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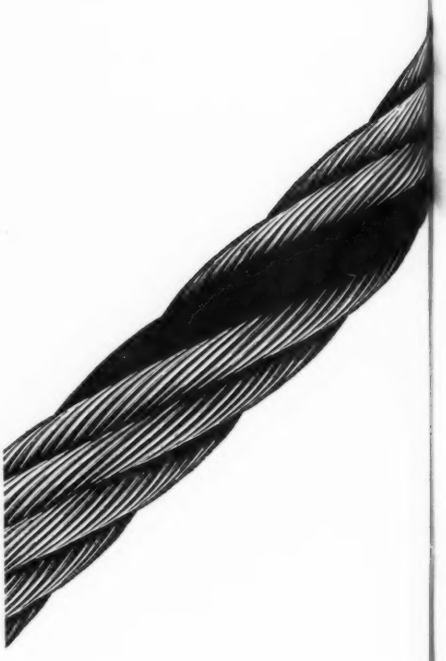

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The Month's HIGHLIGHTS in OILDOM

By J. L. DWYER

THE past month in the petroleum industry has been marked by litigation, legislation, rulings of various oil regulatory bodies and commissions, and the annual meeting of the American Petroleum Institute at Houston.

During the past month there has been a rush to install pumping equipment in the East Texas field, and a survey reveals that there are approximately 700 wells rigged up for the pump. While the number of pumping wells in the field has not displayed any remarkable increase, and now stands at approximately 270, there is evidently a desire on the part of operators to have their wells ready for the pump in the event that a concerted rush to purchase pumping equipment should be witnessed during the winter months. Anticipation of unfavorable weather conditions which last year seriously hampered operations in this field, may have much to do with the inclination of the operators to protect themselves against such emergencies by the installation of equipment at the present time. Pumping material which is purchased new is, for the most part, heavy duty equipment.

A two-months' deadlock on the crude oil price situation was broken when on December 14, The Texas Company announced a revised price schedule, which reduced oil prices by about 20c per barrel in Oklahoma, Kansas, Texas, Arkansas, Louisiana, and New Mexico. In a statement which accompanied the new schedule, R. C. Holmes, President of The Texas Company, stated that the company sought to establish prices "more in line with realization values." A flat price of 75c per barrel is set for East Texas by the new price arrangement. This constitutes a reduction of 35c a barrel. West Texas is reduced 25c a barrel and placed at 50c by the action.

The price problem has brought about a novel situation for the past two months, when, after the Sun Company announced an increase of 12c a barrel on crude oil, the majority of crude purchasers fell in line and announced that they would pay the Sun price. The Stanolind Crude Oil Purchasing Company, the Carter Oil Company and Humble Oil and Refining Company failed to advance their posted prices for crude in the territories in which they are active, and for 60 days the Mid-Continent and Gulf Coast regions have labored along under a dual price schedule.

Passage of the Market Demand law last month by a special session of the Texas Legislature gave additional power to the Texas Railroad Commission in handling the oil production of the state. Under the new law it will be possible for the commission to regulate the production of oil to the actual demand. The law resembles the Oklahoma law, which some time ago was upheld by the U. S. Supreme Court, and which was a factor in preventing a collapse of the oil market when the great Oklahoma City field was in process of development.

An important decision was handed down by the U. S. Supreme Court December 12, which stated that Governor Sterling of Texas acted without authority when he declared martial law in the East Texas fields and placed the region under the control of troops.

Production and Refining Figures Furnished by the American Petroleum Institute

Crude Runs to Stills, Gasoline and Gas and Fuel Oil Stocks, Week Ending November 26, 1932

(Figures in Barrels of 42 Gallons Each)

DISTRICT	Per Cent Potential Capacity Reporting	Daily Avg. Crude Runs to Stills	Per Cent Operated of Total Capacity Reporting	Total Motor Fuel Stocks Thousands of Bbls.	Gas and Fuel Oil Stocks
East Coast	99.1	448,000	70.1	11,768	9,277
Appalachian	95.0	89,000	64.7	1,724	759
Ind., Ill., Ky.	97.5	319,000	75.2	6,226	3,863
Okla., Kans., Mo.	85.2	195,000	49.8	4,721	2,821
Inland Texas	59.2	91,000	48.7	1,427	2,134
Texas Gulf	97.7	390,000	72.0	5,715	9,156
Louisiana Gulf	97.3	91,000	64.1	1,387	3,319
No. Louisiana-Ark.	88.5	43,000	54.4	237	506
Rocky Mountain	90.8	32,000	23.2	1,089	443
California	94.6	428,000	49.4	14,790	100,248
Total Nov. 26, 1932	91.9	2,126,000	60.0	49,084	132,526
Total Oct. 29, 1932	93.6	2,040,000	59.5	49,477	133,904

Daily Average Production

(Figures in Barrels)

	Week Ended Nov. 26 1932	Week Ended Oct. 29 1932	Week Ended Nov. 28 1931
Oklahoma	366,800	395,400	523,850
Kansas	102,200	95,900	104,950
Panhandle Texas	45,450	44,100	56,150
North Texas	47,850	47,350	55,950
West Central Texas	24,750	24,850	26,250
West Texas	165,150	148,900	203,000
East Central Texas	49,300	49,350	56,500
East Texas	360,000	341,800	387,950
Southwest Texas	53,300	52,900	58,950
North Louisiana	28,900	29,300	29,150
Arkansas	34,050	34,000	37,500
Coastal Texas	123,850	126,300	127,500
Coastal Louisiana	34,800	34,750	32,150
Eastern (not including Mich.)	96,800	98,900	107,550
Michigan	19,250	22,700	15,150
Wyoming	34,600	34,000	36,450
Montana	6,400	6,400	7,750
Colorado	2,750	2,700	3,800
New Mexico	31,450	31,900	44,150
California	471,600	475,100	505,400
TOTAL	2,099,250	2,096,600	2,420,100

NOTE: Stocks at refineries, except in California district, which includes stocks on finished gasoilne and engine distillate at refineries, water terminals and sales distributing stations and amounts in transit thereto.

Cosden to Spend $300,000 on Plant

Expenditure of $300,000 for improvement of a refinery and producing properties of Cosden Oil Company in the Big Spring district will start early next year, according to George N. Moore of Fort Worth, Texas, receiver with Henry Zweifel for the Cosden Oil Company.

Details of the improvement program have not been perfected by receivers, but the total sum of $300,000 expenditure of which was authorized by Federal Judge James C. Wilson in Fort Worth, will be made within the Big Spring district.

Cosden Oil Company's refinery at Big Spring has rated capacity of 10,000 barrels daily and is at present equipped with four Jenkins cracking process units.

Moore and Zweifel have kept the refinery in operation although at a rate below its capacity.

Cosden Oil Company has a number of producing leases in the Howard and Glasscock county district and part of the authorized expenditure likely will be used in reconditioning field properties.

Oil Board, Optimistic, Urges Production Control

Its markets comparatively intact, crude oil prices improved, domestic production showing signs of stabilization, refinery activities due to reflect improvement, and marketing capable of betterment by pending modification of statutes—so the Federal Oil Conservation Board broadly views the petroleum industry in its fifth report to the President of the United States.

"The American oil industry gives indications of being the first basic industry to emerge from the world depression," the report begins. It ends by saying: "Certainly the oil industry, one major business with a comparatively intact market, never had a better opportunity to serve the country, and the country never had a more vital interest in the purchasing power of the industry."

The board reported crude oil price at the end of the first half of 1932, although still at the border line of production costs, were higher than a year ago, and five times the 1931 lows. Demand was reported as fairly well sustained, with efforts to stabilize domestic production appearing certain to strengthen further the industry's position. Stocks have been reduced; and natural gas wastage, so far as can be measured, is far less. Conservation statutes of two states have been sustained by higher courts. Production in every major area is under proration, while imports have been restricted. Bills are pending in Congress to authorize an interstate agreement to place coördination of production programs upon a permanent basis. A discouraging note was sounded in the reported failure to control excessive offset drilling.

An "invisible inventory" of crude oil, caused by offset drilling and quickly convertible into gasoline, was said to have stimulated the building and operation of excess refinery capacity, a factor in the demoralization of markets. The board reported a continuing failure to reduce refinery operations to accord with market demands. Revision of anti-trust laws, sufficiently general to include refining activities, is not in immediate prospect, the board said, adding it is not certain that these laws are as great a deterrent to coördination of refinery runs as are competitive tendencies within the industry. It expressed the opinion "there is room for greater coöordination under existing statutes."

Discussing reserves, the board reported that discoveries since 1926 have raised the current classification of known reserves to 10 billion barrels. "Future discoveries may raise it further," it was explained, "but the day of exhaustion is merely postponed a few months or a few years by each new discovery." In an appendix entitled "Conservation and the Diminishing Reserves," the board stated conditions demonstrate that unless producers of oil and gas apply the factual information available and the public takes greater interest in the fundamental concepts of producing oil and gas in their relation to national defense and diminishing supply, "all rational and scientific efforts toward true conservation (which means 'a wiser and more efficient use of natural resources') will be retarded, and the Nation's reserves will be subjected to uncalled for depletion, because of misinformation, misinterpretation, and in some instances, misrepresentation."

Revision of Oil Rules is Sought

The Public Service Commission of Kansas met last month at Wichita to hear two matters that operators in the Voshel and its south extension, and in the Ritz-Garrett-Decker areas of McPherson county have laid before the Sunflower regulatory body.

Derby Oil Company has made a nomination for oil from the Hunton lime area, as a result of it getting a well in 33-21s-3w, and about a mile and one-half south of the present deep sand production in the Voshel pool. Derby officials requested that the extension be declared a separate pool and that their nomination be considered for that area only and not as a part of the Voshel pool, as it is now considered for proration purposes.

Dickey Oil Company stated that the present minimum well allowable of 100 barrels a day given chat wells is working a hardship on the larger wells and is not ratable taking, as it allows smaller wells to run a much greater percentage of oil than the larger chat wells.

Marvin Lee, chairman of the oil advisory committee of the commission, will submit a report of the two matters.

Commission Issues Questionnaire

The Texas Railroad Commission has issued a blanket questionnaire to all crude purchasers, present and prospective, to file detailed information as to its prospective purchases from December, 1932, to March, 1933. If definite information is not available for the February and March demands, the best estimates are asked. The information was sought for the entire state, but particularly for East Texas.

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224 East Texas Tests are Showing Salt Water

A report from the salt water department of the Texas Railroad Commission for the last month shows there are 224 tests in the East Texas field which are showing salt water at this time. Of this total five are in the Gregg district of the Longview area.

Joiner pool has 70 wells producing salt water. In the Kilgore pool there are 89 wells which are showing salt water.

Pure Oil Building Power Plant

Work has been started on a one-story building to house an electrical plant to furnish light and power to the Pure Oil Company refinery at Muskogee, Okla. The unit will cost $13,000. Three Diesel engines and electrical equipment will be installed by the contracting company. Any one of the engines has a capacity to supply the entire plant with electric power. They will be fueled with oil.

The plant is expected to be in operation by January 1.

California Sounds Note of Warning

In a signed statement, three directors of the Oil Producers Sales Agency of California point to the dangers which confront the industry on the Pacific Coast:

It is clearly evident that the operators in California are producing more crude oil than the pipe line companies can buy.

The undersigned, directors of Oil Producers Sales Agency of California, make this statement after careful study of the entire situation:

1. The purchasing companies have been carrying immense stocks for years. These stocks constantly deteriorate as to quality, gravity and volume, and upon these stocks these companies have paid insurance and taxes for years.

2. While carrying these immense stocks, the purchasing companies are, with us, in the midst of the economic depression.

3. These stocks once represented a reasonable "economic reserve," sometimes called "days' supply." But as the daily demand has lessened, the reserve has relatively increased, until now it is obvious that these stocks represent a wasteful over supply—wasteful of the product, wasteful as to tax liability on the industry, and wasteful as to all carrying costs.

4. Without the integrated unity and strength of these pipe line companies, the industry would descend into a disorganization most disastrous to the small producer.

5. Nevertheless, the industry as a whole has insisted that none of these stocks be withdrawn from storage, and has allowed the purchasers of its crude oil to stagger along with the oppressive burden.

6. Contemporaneously, however, with the increase of the burdensomeness of this storage, the independent has been relieved of his oil day by day. The independents carry none of the burden of storage. Their product is sold and paid for promptly. In no other industry does the big competitor give so great a relief to the small competitor.

7. This relieving of the producer, by the pipe line company, must be and is a drain upon the strongest cash reserves, and a strain upon the ablest management.

8. This cannot continue. It is magnified during the depression, when demand is less and prices are less.

9. The independents are responsible for their own curtailment. They have determined that 440,000 barrels per day is the limit of the buying capacity of the purchasing companies. That figure was fixed after carefully studying, not alone the "consumer demand" but the ability and capacity of the pipe line companies to buy.

10. No matter what the reason, the pipe line companies have for years been adding the excess production to storage and the "days' supply" has been mounting by reason of decreased demand. If purchase of independent oil is to continue, it is imperative that California's daily production be limited to 440,000 barrels.

11. It is not a question of aiding our purchasers; it is a question of saving the independents who will suffer most through our imminent collapse.

12. This collapse is impending and the undersigned, directors of the agency, serving on the Executive Committee for Equitable Curtailment, send this warning as our analysis of the picture. We have worked for the benefit of all producers and have no motive except to help the industry and especially the independent producer. We do not want a collapse, which we know will react first against the welfare of independent producers, some of whom will be ruined if curtailment fails.

13. The producer who thinks he is but one among a thousand, and that curtailment will succeed without his efforts, has flouted his responsible status as an individual and weakened his self respect. Yet, if he holds no such feeling, the plain old American doctrine of reciprocity ought to hold every single producer in line.

14. It is evident that continued over-production now means suicide for the industry.

RALPH B. LLOYD, R. A. BROOMFIELD, WM. H. GEIS.

Seminole Pools Under Proration

Two fast developing pools of Oklahoma were placed under the regulation of the Oklahoma corporation commission this month—the West Konawa pool of southern Pontotoc county and the West Holdenville field of western Hughes county

The first pool, with a total of five wells, has a potential production rating of 2,175 barrels daily. The field will be allowed to produce 800 barrels a day. The wells in the field and their potentials are:

The Gypsy Oil Company and others No. 1 Grey, 1330 barrels.

The Gypsy Oil Company and others No. 1 Masters, 640 barrels.

Magnolia Petroleum Company No. 1 School land 16, 125 barrels.

Magnolia Petroleum Company No. 1 School land 15, 30 barrels.

Arrow Drilling Company No. 1 Noble, 50 barrels.

Because of a large accumulation of underproduced oil, the three latter wells will be allowed to produce approximately 100 per cent pending the making up of the underage, at which time they will revert to the schedule.

Thirteen wells in the West Holdenville pool, having a daily potential production of 8000 barrels, will be allowed to produce 3 per cent of their rating, plus 20 barrels per day, the entire field not to produce over 500 barrels daily.

Persia May Cancel Big Oil Concession

The Anglo-Persian Oil Company representative in Teheran, Persia, has received notification from the Persian government purporting to cancel the 500,000-square-mile Darcy oil concession.

The communication stated the willingness of the government to discuss new terms, but the oil company intimated in reply that there is no provision for cancellation in the concession, and such notification cannot be accepted.

Oil Curtailment in East Continues

Both South Penn and Tide Water Pipe Line Company have notified producers on lines of the Bradford Transit Company, in Bradford and Alleghany district of Pennsylvania and New York to continue during December the present oil production curtailment. Purchases will continue to 75 per cent of base amount of crude contracts, same rate in effect since September 1. Thirty per cent curtailment will remain in force in the lower Pennsylvania grade fields in December, South Penn announced.

Latest Activities in the Oil Fields

THE first touch of winter had a tendency to slow down drilling over the nation, and with zero weather experienced in the majority of regions in which the oil field activities are located, much drilling time was lost. A shortage of water in many territories also tended to slow up drilling, and while the figures showing the number of completions for November are almost constant with those for October, the results of December should show a decided drop.

From the point of new activity, the Conroe field of the Gulf Coast region of Texas is the most important spot, and looks larger in point of area every week. When this field, which has production at a depth of 5,200 feet, was first discovered, it was believed that it would parallel in area the majority of Gulf Coast fields, but the drill has caused a revision upward of original estimates, and at the present time the producing wells of this pool are scattered over an area five miles long by three miles wide. To date 64 wells have been drilled at Conroe, almost all of them producers, and there are 46 active drilling wells, with 21 rigs and 23 locations, in this field.

The entry during the last month of the Tidal Oil Company into the Conroe field gave the area another major company. The Tidal purchased a substantial interest in the Strake properties, taking over the operation of these properties.

The great East Texas field, of course, still dominates the petroleum picture, being five or six times larger than any oil field found in America to date. Over nine thousand wells have been completed in this great field to date, but the big drilling rush is practically over, and when contractors finish up the present crop of drilling wells, in all probability they will find it necessary to turn their eyes toward Conroe or some other spot for additional work, or "stack up" the tools. The majority of companies in the East Texas field have pretty well drilled up their properties, and any future work in this area will, for the most part, consist of extensions to the field which may be found from time to time, and also the drilling of inside locations. In many cases where the operators are amply protected with acreage holdings of good size, they will be slow to incur the expense of inside drilling at least until such time as an improved crude price condition is in evidence.

The River Bed sector of the East Texas field continues to furnish the most active part of the area, and conditions in this spot have undergone several changes due to rulings of the State of Texas.

The next two months should witness a substantial reduction in the number of drilling wells which are being carried in the East Texas drilling reports, and unless something unforeseen should occur, the spring will witness the finish of the drilling campaign in this area.

What has been regarded as one of the most important wildcat wells in Texas found only salt water at a depth of 6163 feet and may be plugged back to an upper sand at 6054-6069 feet, in which a showing of oil was found. The well is the Shell Petroleum Corporation and Penn Oil Company's No. 1 Zwayze in Leon County, Texas. It is about 75 miles north and slightly west of the Conroe field, is located on an exceptionally broad structure, and has been regarded by many as having exceptional potentialities on account of its excellent geological prospects. Several who had studied the region believed that this well would prove to be the forerunner of a field as extensive as East Texas.

Interest in the West Texas fields was revived when Fred Turner and Others' test No. 1 Addis in block 43 of the T. & P. survey of Ector county struck some oil at a total depth of 3924 feet. The well made several flows through a small choke, and the output is being run to lease tankage. There have been a few purchases of leases as a result of this discovery, although any great activity is not expected at this time.

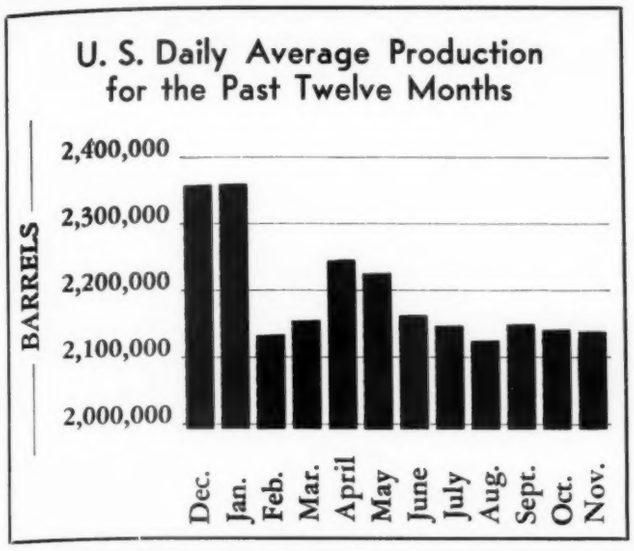
An interesting development in the Texas Panhandle occurred this month, when members of the Railroad Commission met with oil and gas operators in an effort to have the purchasers in this area take their gas purchases ratably from all wells in the field. No decision was reached as a result of the meeting.

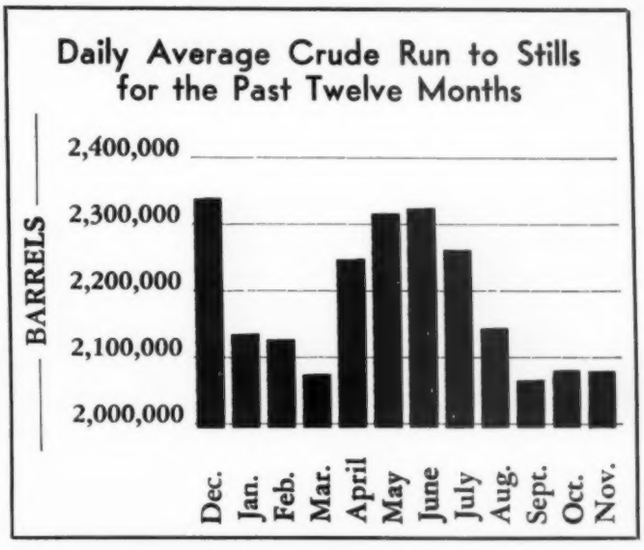
The California fields are fairly quiet. Kettleman Hills had an important completion this month, when the North Dome Association's No. 47-P was completed at 7,081 feet. This well was good for 500 barrels of oil and 23,000,000 feet of gas daily.

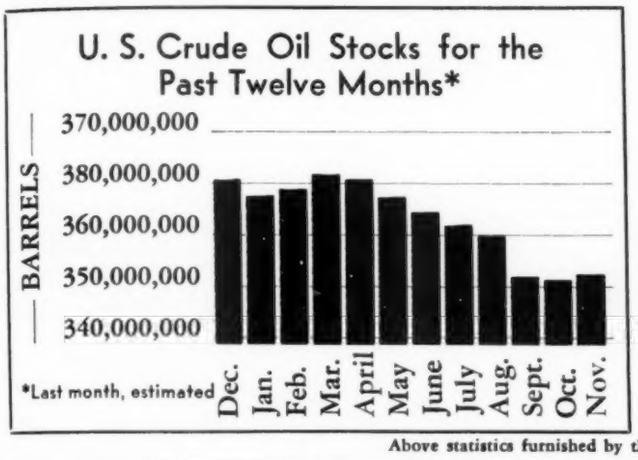
In the Dominguez field of California a new well which occasioned some comment was the Republic Production Company's No. 1 Childs, which was plugged back to the 4500-ft. sand after recording a failure in the deeper pay. It is good for 700 barrels daily. This well was drilled in territory which had been condemned by many and was thought to have slight chances for production. On the famous Lloyd property in the Ventura Avenue field, the Associated Oil Company completed Lloyd No. 131, which made 500 barrels daily. Very few properties can show the high well numbers which this lease exhibits.

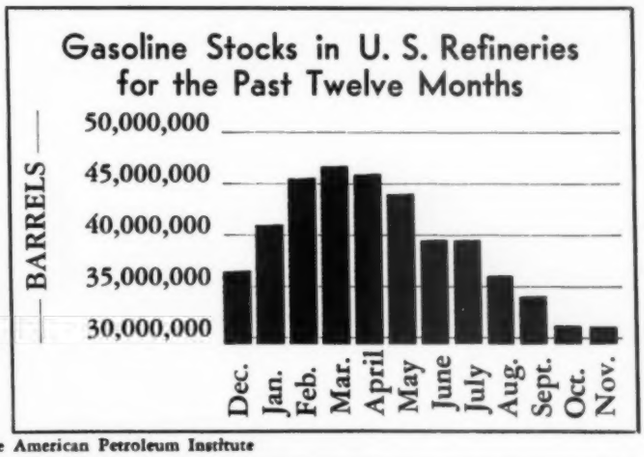
AVERAGE CRUDE OIL PRICES

California		Texas		Illinois	$1.10
Playa Del Rey	$ .78	North Central Texas	$1.04	Kentucky	1.05
Coalinga	.55	Panhandle	.91	Indiana	.75
Long Beach	1.00	West Texas	.90	Ohio	
Montana	1.05	Gulf Coast	.96	Lima	1.15
Wyoming	.92	Darst Creek	.85	Southwest Ohio	1.25
Colorado	.92	East Texas	1.10	Michigan	.85
New Mexico		Kansas	1.04	Pennsylvania	
Northwest New Mexico	.65	Oklahoma	1.04	Bradford	1.72
Hobbs	.90	Arkansas	.82	Southwest Pennsylvania	1.05
		Louisiana		West Virginia	1.52
		North Louisiana	1.04		
		Coastal Louisiana	.96		









Above statistics furnished by the American Petroleum Institute

Summarized Operations in Active Fields for November, 1932

Fields	Completions	Producers	Locations	Rigs	Drilling Wells	Depth of Production	No. Casing Strings	Gravity of Oil	Type of Tool Used
Texas									
East Texas	423	402	358	284	226	3600	2	40	Rotary
Duval County	14	12	18	14	30	2300	2	22	Rotary
Panhandle	14	12	21	5	47	2900	2	40	Rotary
Conroe	21	20	43	21	46	5200	2	38	Rotary
Oklahoma									
Oklahoma City	12	11	4	10	26	6500	3	39	Rotary
Kansas									
McPherson	16	14	12	13	46	2900-3400	2	38	Rot.-Cab.
Ellsworth Arch	3	2	6	15	32	3300	4	37	Cable
California									
Kettleman Hills	2	2	1	2	11	8300	3 or 4	40	Rotary
Long Beach	3	2	2	3	8	7000	3	26	Rotary

Field Activities by States for November, 1932

State	Completions		Producers		Locations		Rigs		Drilling Wells		Production, 1931 (in Barrels)
	October	November	October	November	October	November	October	November	October	November	
Arkansas	0	3	0	1	2	2	6	9	27	23	15,425,000
California	23	19	17	15	20	18	12	10	107	99	188,575,000
Colorado	0	2	0	1	2	2	9	10	66	62	1,510,000
Illinois	10	8	2	3	0	0	1	2	16	14	4,850,000
Indiana	18	16	10	7	0	0	4	3	65	67	830,000
Kansas	51	59	36	33	47	43	48	52	120	108	37,950,000
Kentucky	36	39	23	25	0	0	10	12	61	54	6,490,000
Louisiana	48	51	30	29	43	37	40	42	131	124	22,325,000
Michigan	32	26	20	17	18	16	38	36	64	66	3,730,000
Mississippi	3	2	1	1	1	1	1	1	14	13	Gas. Prod.
Montana	2	7	1	3	12	9	9	7	48	41	2,855,000
New Mexico	10	7	9	5	10	10	7	5	52	47	15,250,000
New York	7	9	7	8	0	0	4	3	11	9	3,400,000
Ohio	68	51	37	24	0	0	31	36	121	110	5,315,000
Oklahoma	100	114	60	59	92	87	129	121	276	309	177,750,000
Pennsylvania	81	92	79	80	0	0	20	12	84	97	11,225,000
Texas	711	719	592	503	531	556	319	345	885	912	330,720,000
West Virginia	21	18	19	13	0	0	15	12	41	37	4,480,000
Wyoming	2	3	0	2	1	1	13	10	69	62	14,725,000
Total	1223	1245	934	829	789	782	715	728	2255	2254	847 413 000

Progress of Major Pipe Line Work

By J. H. DAMERON

FOR the first time in several months the prospect of considerable new trunk line work being started is brightening an otherwise dull period for transporting companies.

All of the prospective new work centers about the plans of companies transporting gasoline by pipe line. Contracts were recently awarded to a Detroit firm for the construction of a 6-inch gasoline line from Toledo, Ohio, to Detroit. This line will be built by the Pure Oil Company and associated interests.

The most recent announcement is to the effect the White Eagle Oil Company (Standard of New York subsidiary) is contemplating the construction of a gasoline pipe line from its Augusta, Kan., refinery to Kansas City, Mo., and possibly on to St. Louis, Mo. The White Eagle Oil Company is completing engineering surveys and reports indicate the company is purchasing right-of-ways for the line. For some time the White Eagle Company has been considering building a line to Kansas City and St. Louis, where the company has a wide distribution of its products or contracting its shipments to these points with a pipe line company.

Both the Phillips Pipe Line Company and the Great Lakes Pipe Line Company pass near Augusta and have lines to Kansas City. The Phillips line extends on east from Kansas City to St. Louis.

In the event the White Eagle Oil Company should contract to ship in either of the two mentioned lines the additional load would perhaps result in considerable loop work or the adding of additional station capacity for either system. Both pipe line companies were operating very close to their maximum capacity during the peak of the seasonal demand for gasoline last summer.

One of the most persistent rumors in the Mid-Continent is to the effect the Phillips Pipe Line Company may extend its line, now terminating in St. Louis, to Indianapolis, Ind. The Phillips Petroleum Company, parent organization of the Phillips Pipe Line Company, is reported considering the purchase of additional outlets in the Indiana territory. In the event the purchase is made it is reported the additional volume would result in extending the pipe line on east.

Detroit Southern Pipe Line Company, owned by the Pure Oil Company and associates, has awarded the contracts to a Detroit contractor for the construction of a 45-mile welded 6-inch gasoline line from Toledo, Ohio, to Hamtramck, an industrial center in the northeastern part of Detroit. The line and its pumping equipment is estimated to cost about $500,000. Construction work is expected to be started within a short time.

Next spring will unquestionably witness many short extensions of gasoline lines, not only on the Mid-Continent-Great Lakes systems, but also on the gasoline carriers in the East. This form of gasoline transportation is becoming very popular and is said to have many advantages over rail shipment of finished products.

Another interesting phase of pipe line work which seems destined to show some life is the extension of natural gas lines to serve industrial communities not very far removed from the present lines of the systems. There are at least two important gas transporting companies in the Southwest which have decided that small extensions to their present systems could be made, taking advantage of current prices of material and cost of labor; and while in many cases the load resulting from these extensions would be unimportant, the extensions could be made self-supporting and would to some extent have a part in bearing the load of the company's fixed charges.

From Tennessee comes the report that the Standard Gas Company, Inc., formerly known as Dickson County Gas Company, will construct a natural gas line from Dickson County to the city of Nashville. The line will cover a distance of 30 miles and is reported to be 8-in. Work is supposed to be started within 90 days, under the terms of a franchise which was awarded by the city authorities of Nashville to the Standard company.

In Michigan, J. P. McCloskey of Tulsa, Okla., and associates are reported ready to construct a 40-mile gas line from the Mount Pleasant field to supply several towns, including St. Louis, Wheeler, Hemlock and Breckenridge, Mich.

In the East Texas territory, the Atlantic Pipe Line Company has installed a booster station on the line from East Texas to the Gulf Coast. The booster was installed at Zavalla, in Angelina County, and it increased the capacity of the line 20,000 barrels daily.

That the Pacific Northwest may be served by natural gas lines was indicated at a recent hearing held before the California State Railroad Commission at San Francisco when the Pacific Gas & Electric Company made application for approval of a provisional contract which it has made with the Standard Oil Company of California, and under the terms of which Pacific Gas & Electric obtains the right to use all natural gas which the Standard has not contracted. It was indicated at the hearing that natural gas may be piped to the states of Oregon and Washington.

The possibility of furnishing natural gas to supply the city of Detroit has again occasioned some comment, especially since the voters of that municipality rejected the proposition of the city's entry into the municipal gas business. In the event that natural gas is brought to Detroit, it seems logical that one of the existing systems running out of Texas should be extended to serve that city, as either of two systems could easily make the necessary extensions and handle the added load.

This matter will in all probability be brought up next spring, and possibly some arrangements may be made with the Detroit City Gas Company (a private corporation) which now operates in Detroit.

In the East, a short 6-in. line is reported ready to be built by the Columbia Gas & Electric Company. It will run from the company's trunk line station at Pipestem, W. Va., and will serve the cities of Princeton and Athens, W. Va. The distance of the line is approximately 20 miles.

The only important foreign pipe line project now under way, the line of the Iraq Petroleum Company, is at present laying river crossing on the Tigris and the Euphrates, both of which streams are expected to furnish some construction difficulties.

. . . YET IT COSTS LESS!

REPUBLIC salesmen everyday hear prospective buyers of Toncan Iron Pipe say, "But it costs more." But that's no argument against buying it—at least hundreds of actual users don't think it is, because in the end it actually costs less.

Bare pipe prices are no basis for figuring values. The true yardstick is the cost of the pipe installed divided by the service life. Installation usually costs more than the pipe and fittings, and when failure occurs the entire installation cost is lost forever. Then it costs money to tear out the old, and the original cost must be paid again for the replacement. Figure it this way. One kind of pipe lasts, say 5 years. Another 10 years. Even if the 10 year pipe costs twice as much as the other, it saves money for the user—saves the entire cost of tearing out the old and replacing with the second installation.

Toncan Iron Pipe lasts longer because it is made from an alloy of scientifically refined iron, copper and molybdenum. It costs more to make, yet it costs less to use because its resistance to corrosion among ferrous metals is exceeded only by the stainless irons and steels. Wherever the spectre of rust raises its ugly head, Toncan Iron Pipe will save you money.

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The Month's Activities in Refining*

By F. R. STALEY

THE Empire Oil & Refining Company is installing a 6,000,000-cu. ft. recovery and stabilizing unit at Ponca City, designed by Black-Sivalls & Bryson.

The Burrell-Mase Engineering Company is building a stabilization plant at Cushing, Okla., for the Deep Rock Oil Corporation.

The E. B. Badger & Sons Company is building a vacuum re-run unit for pressure distillate at Drumright, Okla., for the Tidal Oil Refining Company.

The Soars-Lovelace Engineering Company has completed a modernization program at the Kansas City, Mo., refinery of the Altitude Petroleum Corporation.

The Sinclair Refining Company plans alterations and improvements to its refineries in Marcus Hook, Pa., and East Chicago, Ind.

D. K. Knott and Associates plan the construction of an oil refinery at Edmonton, Canada.

The Easton Oil Company will build a refinery at Mellfort, Sask., Canada.

Gyro Vapor-phase cracking units operated by the Hayton Refineries, Ltd., in Killingholme, England, are being altered to incorporate the latest developments in this process.

The Skelly Oil Company has introduced a "tailor-made" gasoline on the market which possesses high test and high anti-knock properties. Specifications to best meet the driving conditions existing in each state in which the company markets this product were based on actual operating data collected by eight test cars. These cars were all of different make and were each equipped with four fuel tanks. The cars were fitted with laboratory testing equipment so that the research department was able to collect an enormous quantity of valuable data from car operation.

A number of refineries are blending lubricating oil into their motor fuel for valve and upper cylinder lubrication.

The Standard Alcohol Company has been formed to take over and develop the interests of the Standard Oil Company of New Jersey and the Petroleum Chemical Corporation for the manufacture of higher alcohols and solvents.

E. B. Badger & Sons Company have been awarded a contract for the construction of a 4000-barrel tube and tank cracking unit at Avon, Calif., for the Associated Oil Company. C. F. Braun & Co. was awarded a contract by this company for the erection of a vacuum re-run unit.

Alco Products, Inc., have been appointed exclusive licensors for the Gyro Vapor Phase Cracking Process in the United States and foreign countries.

Natural Gasoline

The Royalite Oil Company will construct a $400,000 absorption plant in Turner Valley, Canada, scheduled to operate next spring.

The Midland Oil Company will move a gasoline plant to the Conroe field from Coleman, Texas.

G. G. Oberfell discussed the economic outlets for natural gasoline and liquefied petroleum gases before the Houston meeting of the American Petroleum Institute.

George Ratcliffe, of the Baroid Sales Company, was the principal speaker at the December meeting of the California Natural Gasoline Association.

Stocks at refineries Dec. 3, 32,330,000 barrels
Daily average to stills in November, 2,008,000 barrels.
Figures in red show per cent refining capacity operated.

*All statistics as of December 1.

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LOW GUM

THE GRAY PROCESSES CORPORATION

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NEWARK, N. J.

Problems Encountered in Clean

By G. E. HERRMANN
Associated Pip

Pick handle and part of a go-devil lodged in pipe near Station No. 4

WHEN the Associated Oil Company's 6-inch pipe line from Belridge to Monterey, in California, showed a drop in capacity from 12,800 barrels per day to 11,400 barrels per day, due to wax deposits, it was decided to clear the line by the use of go-devils or scrapers. The results proved highly interesting in raising the capacity of the line to 13,300 barrels.

The presence of paraffine wax in the Kettleman and Belridge light crude oils had presented a new problem in oil pipe line transportation in California. Prior to the development in the Kettleman Hills and the Belridge field no trouble was experienced from paraffine wax from oils produced in the San Joaquin valley. But since these fields have been producing oil of about 40.0 A.P.I. gravity with a wax content as great as 3.9 per cent, the pipe lines handling this oil have gradually become coated on the inside with this paraffine, which in some cases caused a loss in capacity sufficient to necessitate cleaning the line.

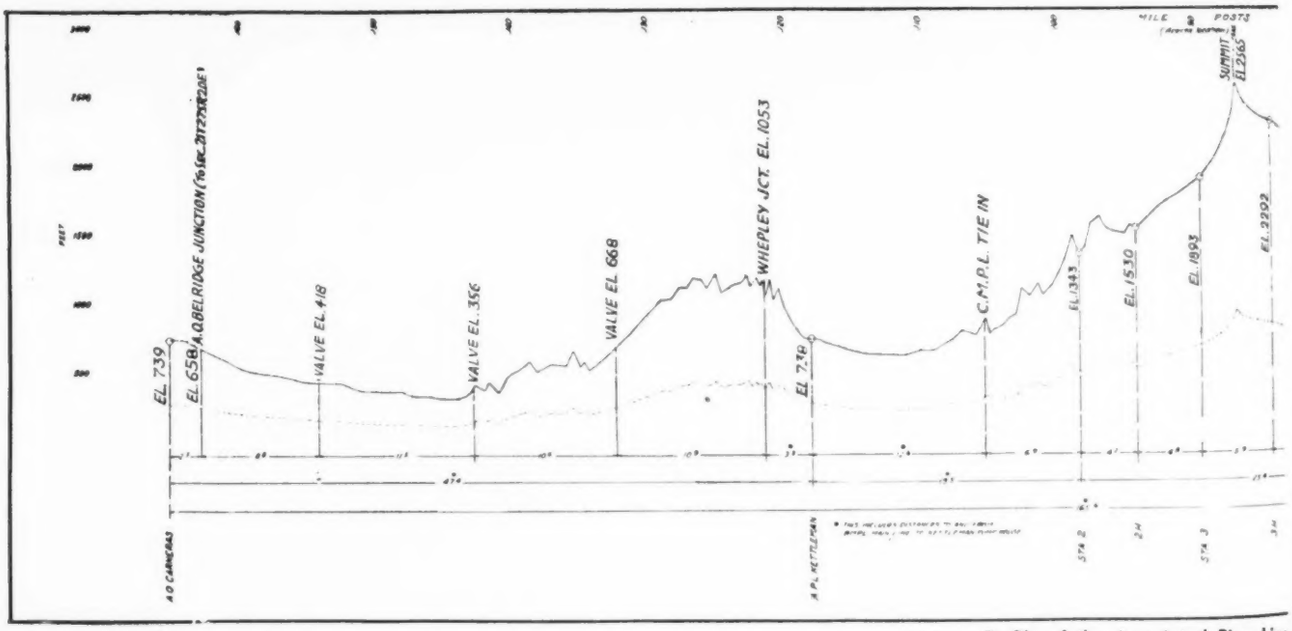
This condition was particularly noticeable in the Associated Oil Company's 6-inch Belridge-Monterey line between Kettleman pump station and Monterey, a distance of 118 miles. This line reaches an elevation of 2,565 feet where it crosses the coast range mountains and terminates at Monterey Bay, where the oil is loaded into tankers for transportation to the Avon, Calif., refinery, and elsewhere.

The portion of this line from Coalinga to Monterey was originally constructed of screwed pipe in 1904 for the transportation of oil produced in the Coalinga field. This oil is heavy and requires heating to facilitate transportation. When the Kettleman Hills and Belridge fields came in with high-gravity oil, it became necessary to reconstruct this old line, removing the collars and welding the joints, in order to handle this light oil. A new welded line was also constructed from the Belridge field to connect with the old line in the vicinity of Coalinga. All of this work was completed in the spring of 1931, the line being put into operation May 1, 1931.

There are five pumping stations, three of which have steam reciprocating pumps, and the other two of which are equipped with motor-driven centrifugal pumps. In addition to pumping Kettleman and Belridge crude oil, this line handles casing-head gasoline about every 100 days for a period of approximately 10 days. When pumping gasoline the two centrifugal pumping stations and one reciprocating pumping station are used.

After reconstruction, the greatest capacity of this line was 12,800 barrels per day of crude oil. When cold weather set in the capacity began to decrease and continued to fall until it had been reduced to 11,400 barrels per day, requiring the maximum pressure of 800 pounds at some pump stations.

As the presence of wax was known it was decided to go-



Profile of the Associated Pipe Line

ing California Oil-Gasoline Line

Chief Engineer,
Line Company

devil the line to remove both the wax and such foreign matter as had become lodged in the line during its reconstruction. The plan adopted was to cut the line in sections and put the go-devil through the line with water.

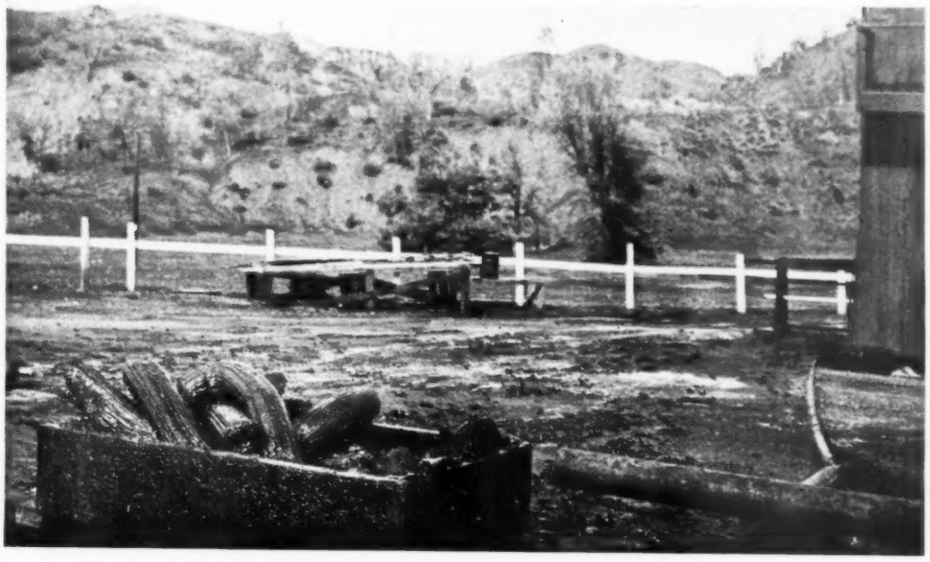
As more than 50 miles of this line lay in rugged mountainous country and contained many angle welds that were too great to permit the go-devils to pass, it was necessary to replace the greater angle welds with bends before starting cleaning operations, and to be prepared to replace other such angles that might obstruct the passage of the go-devil.

A section about a mile long, which contained many angle welds, was selected for test purposes, and it was found that but little difficulty would be experienced from angle welds of less than 30 degrees.

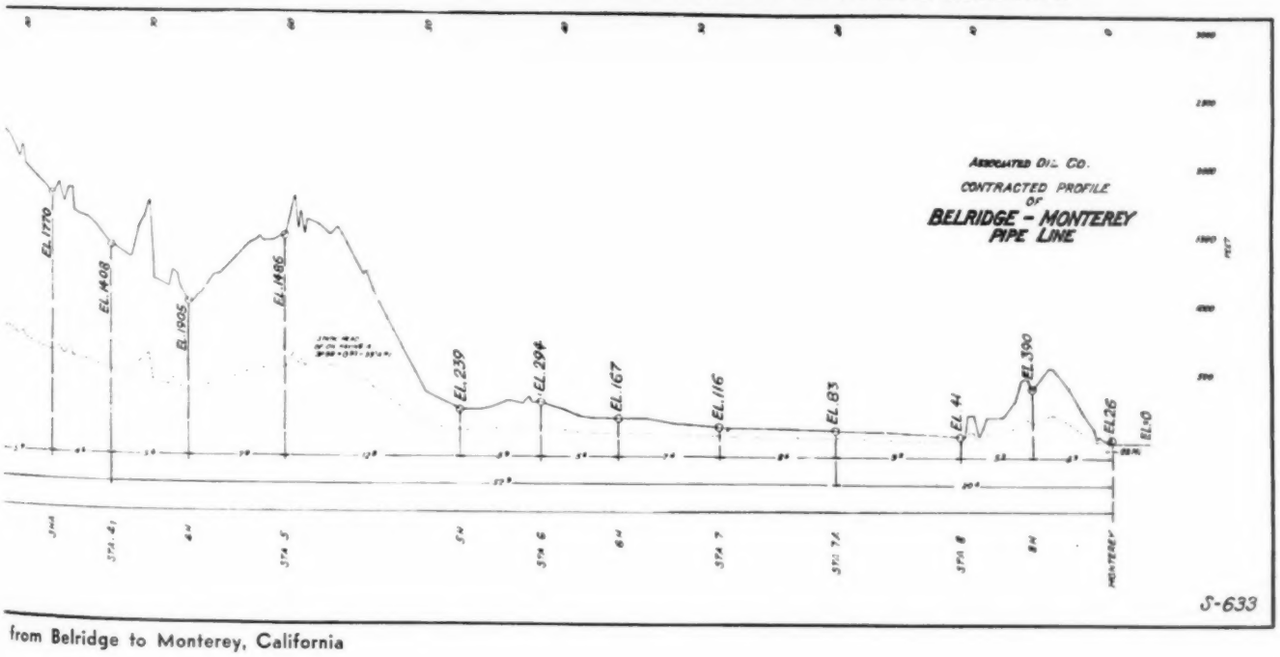
At least three go-devils were used in each section of line, the first go-devil having all the cutter blades removed, the second with half of the blades removed, and the third completely intact with all cutter blades.

The go-devils were placed in the line about one-half hour apart and moved with a velocity of from 2¼ to 2½ miles per hour. At first two men followed the progress of each go-devil on foot for about a mile, when they were replaced by two other men and taken ahead by automobile, where they in turn relieved the second pair. After the men had become familiar with the sound of the go-devil passing through the line, only one man was used to follow its progress. Also, it was found unnecessary to follow the first go-devil after the second section was cleaned, for should it become lodged in the line, it would be located by the second go-devil.

During the cleaning of a section of line in the Salinas valley which was straight and practically level, the men following the go-devil's progress lost track of it because of the noise of automobiles on a near-by highway and the noise of a heavy wind, which drowned out the go-devil's hum. It was then necessary to start another go-devil through this section of pipe and to use all the men to follow it, stationing them as close together as practical. Progress of the go-devil was thus carefully followed, and when it stopped the line was opened



Solid wax cores removed from the line at Station No. 2



from Belridge to Monterey, California

Wax cores removed at Station No. 2

and the other go-devils were found lodged tightly against a pick handle. The first go-devil, with the cutter blades removed, had passed over the pick handle.

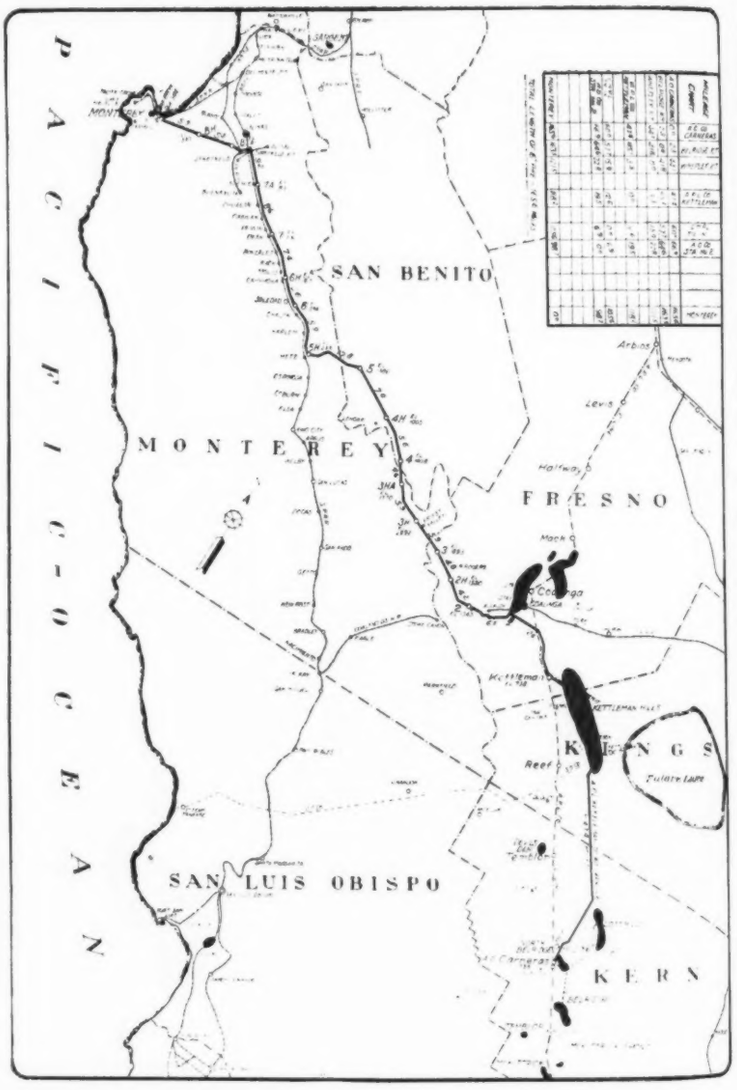
An amusing incident occurred just before the go-devils were lost. The men following the go-devils were having such difficulty hearing them, due to the wind and the noise of passing automobiles, that it was necessary for them to run ahead of the go-devil and lie down with their ears to the ground. This performance aroused the curiosity of motorists and local farmers. As the men approached one farm house, the farmer came out and ordered the man lying on the ground listening for the go-devils, to get up and get away from his property, remarking, "The pipe-liners are so drunk they can only run a hundred feet before they fall down."

As part of this line lies in very rugged country, it had been necessary to snake considerable pipe into place when it was reconstructed. This naturally permitted foreign matter to get into the line along with other miscellaneous construction materials that remained in the line after it was put into operation. This foreign matter consisted of sand, rocks, sacks, pieces of lumber, pick handles, oxygen bottle caps, etc., and was removed from the line by the go-devils. In one section of the line a piece of 2 x 6 lumber 7 feet long was discharged ahead of the first go-devil. This 2 x 6 had been split lengthwise and was approximately 2 x 5 on one end and 2 x 3 on the other end, and had been so thoroughly saturated with oil that it was sufficiently pliable to pass through the angle welds and bends. In another section of the line a 2 x 4 piece of lumber 3 feet long was passed over by the first go-devil which did not dislodge it. But the second go-devil freed it so that it passed on through the line for a distance of over 8 miles. This 2 x 4 created sufficient noise to be easily followed until discharged from the line.

In a straight level section of line, a cap from an oxygen bottle stopped the go-devils at a point where the line was buried more than 3 feet deep. This particular point was along side of a heavily trafficked highway, on the opposite side of which was a grove of eucalyptis trees through which a high wind was blowing. Another go-devil was started through the line and so timed that it would reach the vicinity in which the go-devils were lost during the early morning hours, at which time the wind usually subsided and the highway traffic was at a minimum. When this go-devil stopped the line was opened and all go-devils were found, the first one having wedged tightly against the pipe along with an oxygen cap.

When the go-devils had passed through a section of the line they were carefully examined to determine whether or not all obstacles had been removed. If the go-devils were in good condition it was evident that no obstructions remained in the line. A bent arm or leather support bracket, on the other hand, indicated that the go-devil had passed over some obstacle. In some operations the ends of the scraper blades were broken off by welding beads or stalactites in the pipe.

The amount of paraffine wax removed from the line per mile varied with each section. It was found that the greatest deposit of wax was in the higher altitudes where the pressure was also higher than in other sections of the line. Frow one of these sections, 5.9 miles long, more than 100 feet of solid wax core was removed, and from another section, 9.0 miles long, about the same amount was taken out.



Map showing the Associated Line from Belridge to Monterey, Calif.

Estimating Refinery Construction Costs

By G. W. HEINECKE
Consulting Engineer, Dallas, Texas

IN a previous article* the various items entering into the estimation of a plant were enumerated.

In this and succeeding articles these items will be enlarged and an attempt made to furnish some costs of field work which may be used in estimating. Many of these field costs have been recently secured from various engineers, manufacturers and contracting companies in the Mid-Continent field and represent conservative values. The writer wishes to express his thanks to those engineers and contractors for their hearty and unselfish coöperation.

In this article the plant site will be discussed.

Consideration of the plant site includes clearing and grading, surveying, building roadways, maintenance of plant site during building operations, final clean-up of plant site and removal of trash and excess dirt.

Clearing and Grading

Clearing may require the removal of trees and grubbing of tree stumps, if in a wooded section, removal or blasting of boulders, removal or demolition of old buildings or equipment, and blasting of old foundations if the plant site had been formerly used for other purposes.

The cost of removal of trees varies widely. Some of the smaller varieties, such as mesquite, and small pine trees, may be pulled with the aid of a tractor and winch, while the larger varieties will have to be hewn and the stumps blasted. Also the stand of trees may be either thin or dense. From information secured it appears that the cost of clearing would range from about $15.00 per acre in the case of the thin stand of small trees, to $75.00 per acre in the case of the rather thick pine stands. Grubbing (removal of tree stumps) would be negligible in the case of mesquite to $100.00 per acre in the thickly wooded country around South Texas.

Removal of Boulders and Ledges

The cost of such work varies with the hardness and position of the rock. An attempt should be made to blast the rock into fragments sufficiently small that they can be loaded in sleds and dragged to the point of disposal. If the haul is long, wagons, carts or trucks should be used.

As a guide to estimating, from 1 to 2 lbs. of dynamite will be required to blast 1 cu. yd. of rock. Any one, or a combination, of three methods of blasting may be required, viz., blockholding, or packing the explosive in holes drilled in the rock and tamping with earth, snakeholding, or drilling a hole directly under the boulder in the earth and inserting the explosive, and mud capping, or placing the explosive on the boulder with a cap of mud placed on top. For estimating, providing an air drill is available to drill the holes, an average cost of 40c per cu yd. may be used. If an air drill is not available this cost will be considerably higher.

When using dump carts to haul the fragments, with a haul of not over 500 feet the cost should not exceed 60c per cu. yd. This would allow two men ten minutes for loading, and two men for spreading at 30c per hour, $5.00 per 10-hour day for the team and driver, with a ¾-yd. load per haul. For a haul of 1000 feet the cost, based on the figures above, should be about 80c per yard.

If two teams are used with four men as above, the cost will range approximately as follows:

Distance Hauled	*Cost Yard*
500 ft. to 1000 ft.	40 cents
1200 ft.	45 cents
1500 ft.	50 cents
2000 ft.	60 cents

Grading

Grading costs vary widely from such cases where a steam shovel may be used in large quantities of soft soils to those requiring the blasting of hard rock and the use of scrapers.

If the site is small in area and the average haul about 200 ft. or less, team- or tractor-drawn plows and drag scrapers or fresnos may be used. (It is assumed that the earth removed from the high spots is to be dumped into the low places). If the soil is loam, soft clay or sand, no plowing will be necessary.

As a guide to plowing, a two-horse plow with a driver and a man to hold the plow will loosen about 400 cu. yds. of average soil per 10-hr. day.

If the soil is dense, hard clay, a four-horse plow with three men will loosen about 200 cu. yd. per day. The average yardage per day in plowing is as follows:

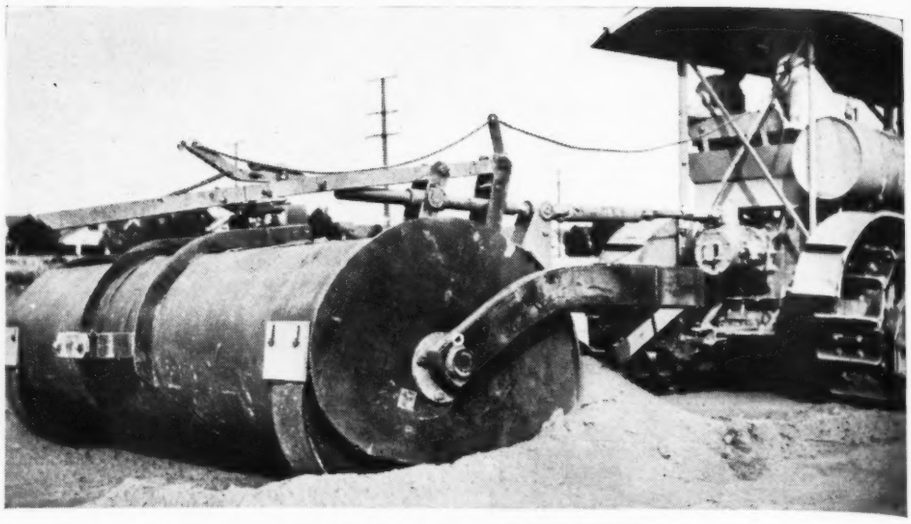
Soil	Labor	CUBIC YARDS Per hr.	8-hr. day	10-hr. day	Cost cu. yd. (1) based on 10-hr. day
Loam	1 driver, 1 holder, 2 horses	50	400	500	.019
Gravel and Loam	1 driver, 1 holder, 2 horses	35	280	350	.027
Fairly Tough Clay	1 driver, 1 holder, 2 horses	25	200	250	.038
Very Hard Soil	1 driver, 1 holder, 4-6 horses and 2 men on plow beam	15-20	120-160	150-200	.011

(1) Costs based on two-horse team, plow and driver at $5.00 per 10-hour day and helper at 30c per hour—includes repairs and depreciation.

Figure 1

*Petroleum Engineer, July, 1932.

Costs will be reduced considerably if a tractor is used for plowing. It is recommended that for maximum efficiency a crawler type tractor of at least 35-hp. be used. A tractor of this size will have a maximum drawbar pull of 41-hp. when running in low gear at 1.84 miles per hour. This is equivalent to 8350 pounds on the drawbar. Driving a winch this pull can be increased to 45,000 pounds and may be used for pulling stumps, setting equipment and a multitude of other labor-saving purposes. If the construction job is of medium size a tractor will repay its cost.



Large wheel-type scraper clearing a site

For purposes of comparison between horse-drawn and tractor-drawn plows, the following table, showing cost of plowing with a 35-hp. tractor, is of value:

Soil	CUBIC YARDS Per Hour	Per 8-hr. Day	Cost per cu. yd.
Gravel and Loam	235	1900	.019
Fairly Tough Clay	170	1350	.026
Very Hard Soil	100	800	.053

A recent development in this line is a new type of plow known as a ripper, a picture of one being shown in Figure 1.

Some of the features claimed for this implement are as follows:

1. Uniform depth of cut.

2. More thorough breaking up of the soil, resulting in greater economy, particularly in grading and scraping. It is especially adapted to hard clays, cemented gravels and in tearing up old macadam roads. In sticky, gummy or buckshot soils, this tool is equipped with wing blades, (not shown in the illustration). These wings raise the top layer of soil in such a manner as to completely shatter it, rather than turn it, as is done in plowing. The effect of this shattering is to aereate and mellow the soil, effectively preventing baking in large lumps as occurs when the soil is turned by a plow.

3. Greater capacity and less power consumption in all kinds of soil.

4. The ripper is controlled by the tractor operator. Therefore, only one man is required for the operation.

Costs of ripping are approximately as follows:

Soil	CUBIC YARDS Per Hour	Per 8-hr. Day	Cost per cu. yd.
Gravel and Loam	1200	9600	.004
Fairly Tough Clay	750	6000	.006
Very Hard Soil	500	4000	.010

Shoveling

If the losened soil is to be hand shoveled into wagons or trucks, the following table will be of service:

COST OF SHOVELING

Type Soil	Cubic Yards per Man Hour	Cost per Cubic Yard 25c 1 hour	30c 1 Hour
Ordinary Medium Soil	1.25	$ .20	$ .24
Sand or Loam	1.25	.20	.24
Heavy Soil or Clay	1.00	.25	.30
Hard Pan	.85	.30	.35

The cost of hauling dirt by means of cart or truck will vary with the length of haul, road conditions, etc. Prices may be secured from teamsters in the vicinity of operations.

Scraping

Drag scrapers are satisfactory for quantities less than 50,000 cubic yards up to a 200-ft. average haul. A two-horse team and scraper can move, in a 10-hour day, the following average amount of loose material:

Length of Haul	Cubic Yards of Loose Earth per 10-hr. Day	Cubic Yards Compacted Earth per 10-hr. Day	Cost Cubic Yard(2) Compact Earth
25 Feet	70	60	.083
50 Feet	60	50	.10
100 Feet	50	45	.11
150 Feet	40	35	.14
200 Feet	35	30	.17

(2) Based on $5.00 per 10-hour day for team and scraper in average soil. No depreciation included. Should soil be hard add 4c per cubic yard.

By compact earth is meant the original earth before loosening. Loose earth usually occupies considerably more space than the original, on which the estimate is to be based.

The average amount of loose earth moved by a 4-ft. scraper and a team of three mules is as follows:

Average Haul in Feet	Average Time per Round Trip, Minutes	Cu. Yds. per Hour Average	Moving Cost per Cu. Yd.(2)
50	1.6	12.7	.076
75	2.0	10.3	.093
100	2.2	9.0	.107
125	2.4	8.0	.120
150	2.7	7.3	.131
175	3.0	6.6	.145
200	3.2	6.3	.152
250	3.8	5.3	.181
300	4.3	4.6	.210
350	4.6	4.3	.223
400	5.2	3.8	.250

(2) Based on 10 scraper outfits working at following costs: Mules $1.00 per day; 10 teamsters at $3.00 per day; extra laborers at $2.00 per day—10-hour working days. Includes depreciation and repairs.

When much earth is to be moved, and where the haul is greater than 300 feet, it is more economical to use a wheeled scraper, drawn by a tractor. Following is some data on tractor scraper operation, based on an 8-hour day:

Tractor	Scraper	Haul Avg.	Amount per Day 8 Hrs.	Cost per Yd. Approx.	Cost of Operation, Depreciation, Etc.
15 HP	4 ft.	200 ft.	250 cu. yd.	$ .08	$20.00
20 HP	5 ft.	200 ft.	450 cu. yd.	.06	25.00
30 HP	6 ft.	200 ft.	550 cu. yd.	.06	33.00
40 HP	7 ft.	450 ft.	650 cu. yd.	.055	35.00
50 HP	8 ft.	200 ft.	800 cu. yd.	.05	40.00
60 Hp	10 ft.	200 ft.	1280 cu. yd.	.05	50.00

In the foregoing discussion, the original cost of the tractor, plow, scrapers, etc., have not been included. It will be necessary for the estimator to determine if the job is of sufficient size to warrant purchasing such equipment, keeping in mind that it will be required for maintenance and may be of use in other construction operations.

The Behavior of Occluded Gas in an Oil Sand Reservoir

By IONEL I. GARDESCU, Ph.D., Petroleum Engineer and Geologist
Professor of Petroleum Engineering, University of Pittsburgh

Part II. The Development of Gas Masses in an Oil Sand Reservoir

Occurrence of Free Gas in a Virgin Oil Reservoir

BEFORE the oil reservoir is tapped for production the gaseous hydrocarbons accompanying the oil may occur under two different sets of conditions, namely: *free gas*, which occupies the structural high parts of the producing horizon, and *dissolved gas*, which is contained in solution with the oil. In addition to the above it has been suggested* that free gas may also be present in a virgin reservoir in the form of small disseminated bubbles, generally referred to as occluded gas. The existence of this gas in an untapped reservoir may be questioned because of the physical instability of such gas bubbles over a long period of time.

Let us consider two soap bubbles (Fig. 7) connected by a small tube provided with a stop cock *a*, which is closed. The two bubbles are blown separately through *b* and *c*. If the two outlets are closed and the connecting valve *a* opened the bubbles, which are of different size, will not tend to balance each other, but on the contrary, the larger bubble will gradually increase until the smaller one is completely dissipated. The small bubble disappears because it has a higher inside pressure than the larger bubble. In both bubbles, the inside pressure is greater than the outside atmospheric pressure and this excess pressure is caused by surface tension forces present in the film of soap solution surrounding the bubbles.

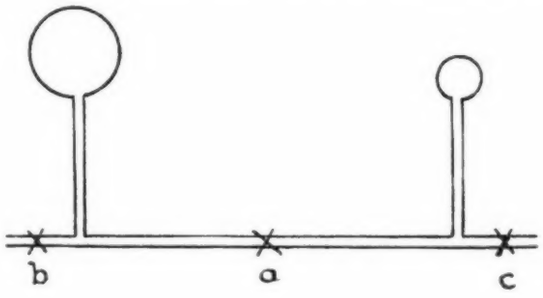


Fig. 7

In a liquid, molecules are equally attracted from all sides, but along a surface or an "interface" molecules are attracted on only three sides. Such molecules are held in place by forces acting in the plane of the surface, which, by its very nature, is always under tension. If a surface of unit width is cut in two halves and one half is replaced by a force sufficiently large to hold the other one in equilibrium, this force will represent the surface tension of that particular interface.

Along a plane interface the surface tension forces have no effect on the pressure of the surrounding medium. However, along a curved interface the surface tension forces exert a pressure in the direction of the curvature, and as the radius of curvature decreases the excess pressure becomes greater. This can be stated mathematically in the following manner:

$$p = \frac{2T}{R} \qquad (1)$$

p = excess pressure on concave side of interface or inside of gas bubble.
T = surface tension force in the interface.
R = radius of curvature.

The surface that separates a gas bubble from the surrounding oil is similar to the soap bubble film and consequently the same relation of pressure, curvature, and surface tension forces is encountered. Thus, by substituting in the above formula the value of R for a small gas bubble, it is readily observed that the excess pressure becomes greater as R decreases, assuming that T remains constant. Inside of a gas bubble or a mass of free gas, an increase in pressure implies a proportionate increase in concentration of gas molecules. If two masses are of different degrees of concentration, diffusion will take place from the mass of higher concentration towards the mass of lower concentration.

In an oil sand reservoir, the gas masses are not directly connected as in the case of the two soap bubbles described above. However, the two conditions are comparable because the oil serves as a transmitting medium for the diffusion of gas. Thus, gas molecules go into solution in regions of high gas concentration, and come out of solution in regions of low concentration. Such a process of diffusion of gas through the oil is extremely slow, but in an untapped reservoir, considered over long intervals of time corresponding to geologic periods, diffusion becomes an important factor.

In a virgin field, by assuming the existence of a large gas mass in association with the oil, it is difficult to conceive how occluded gas bubbles, of higher gas concentration than that of the larger gas mass, may possibly exist.

Formation of Gas Masses

The Necessary Condition of Supersaturation

Assuming that a small gas bubble is formed within the oil mass, the dimensions of this bubble are, to begin with, very small. Such a gas bubble, because of surface tension forces, has an internal pressure higher than that of the surrounding oil. If the surface tension of the oil-gas interface at 500 lb. is taken as 17 dynes per centimeter, then the excess pressure of a bubble of 1×10^{-5} cm. radius may be determined by use of formula (1):

$$p = \frac{2T}{R} = \frac{2 \times 17}{1 \times 10^{-5}} = 3{,}400{,}000 \text{ dynes per sq. cm., or } 46.4 \text{ lb. per sq. in.}$$

The pressure inside the gas bubble is equal to the pressure of the surrounding oil, taken as 500 lb., plus the excess pressure calculated to be 46.4 lb. The concentration of gas mole-

*H. C. Miller, Function of Natural Gas in the Production of Oil, 1929, p. 26. Stanley Herold, Analytical Principles of the Production of Oil, Gas and Water from Wells, 1928, p. 514.

cules in the oil corresponds to its pressure of saturation of 500 lb., whereas the concentration of gas molecules inside the gas bubble corresponds to the total pressure of 546.4 lb. Consequently, such a bubble could not exist under the prevailing pressure conditions because diffusion of gas would immediately take place from the bubble into the surrounding oil.

By lowering the pressure of the reservoir, the concentration of gas molecules in the oil remains constant until free gas is evolved. On the other hand, the concentration of gas molecules in the assumed small gas bubble of 1×10^{-5} cm. radius decreases as the pressure of the reservoir is lowered because the total inside pressure of the bubble is equal to the sum of the outside pressure, or reservoir pressure, and the excess pressure. The latter does not vary materially if R remains constant. It is possible to reduce the concentration of the free gas molecules by lowering the pressure of the reservoir until a condition of equilibrium is established between the gas bubbles and the surrounding oil. In this condition, the gas bubble can exist, but its size will remain unchanged. By further lowering the pressure of the reservoir, the gas concentration of the bubble will be further reduced and the bubble will begin to grow by means of diffusion of gas from the surrounding oil.

A small gas bubble may exist only by virtue of the fact that the surrounding oil is in a condition of supersaturation, the degree of supersaturation depending upon the excess pressure of the bubble. In its early stages of formation, it is necessary for the bubble to be of very small magnitude and in order for such a bubble to develop, the relative degree of supersaturation of the oil must be accordingly high. Since the concentration of gas molecules in the oil does not change, the degree of supersaturation is reached by means of the lowering of the pressure in the reservoir. The magnitude of the excess pressure $\left(p = \frac{2T}{R} \right)$ predetermines the degree of supersaturation, and, therefore, the limit to which the pressure should be lowered before gas bubbles may form.

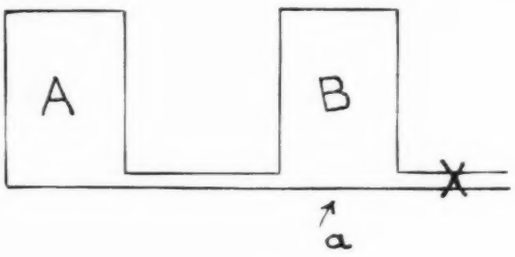


Fig. 8

The Function of Nuclei

The surface tension T has been considered thus far. However, under ordinary conditions it will not be found constant because the gas bubbles produced from solution generally evolve around a solid mass that serves as a nucleus. The presence of nuclei might cause an increase of the concentration of gas molecules, but their important function is to cause a lowering of the surface tension of the oil-gas interface at the points where the new gas bubble is to be formed. Referring to formula (1), a decrease in surface tension T will cause a lowering of the excess pressure p and consequently a lowering of the degree of supersaturation required for the formation of the gas bubbles.

Experiment VI.

The apparatus used contained two glass reservoirs, A and B, connected by glass tubing as shown in Fig. 8. Both reservoirs were filled with gas saturated oil. Precautions were taken to have no free gas present in the system, and by maintaining a pressure above that at which the oil was saturated with gas, the possibility of any gas coming out of solution was eliminated. The pressure of the system was gradually lowered to and below the pressure of saturation. There was no evolution of gas bubbles until a definite minimum pressure was reached. At that point, a small gas bubble began to form on the surface of a minute impurity *a*, which was accidentally present in reservoir B (fig. 8). Once formed, this gas bubble grew until its buoyancy was sufficient to allow it to detach itself from the impurity and rise to the surface of the oil. Soon after, a new bubble formed on the same impurity. During this time, no other bubbles were formed in reservoir A or at any other point in reservoir B. Upon further reductions of the pressure, which increased the degree of supersaturation, it was possible to develop gas bubbles around other impurities.

As has been pointed out, it is not possible to develop gas bubbles from an oil medium that is not supersaturated with gas. In the first case above, the impurity *a* reduced the surface tension of the oil sufficiently to permit the formation of the gas bubble. The other impurities also lowered the surface tension of the oil but not to as great an extent. The degree of supersaturation was not sufficiently large to permit the formation of free gas around these nuclei with a relatively higher surface tension. Later, as the degree of supersaturation was increased, these other nuclei also became centers of evolution of free gas.

If the reservoir contains substances that affect the surface tension of the oil in varying degrees, each one of these substances may become a gas-forming nucleus, provided that the oil has reached the necessary degree of supersaturation for the evolution of free gas. On the other hand, it is possible to have no nuclei forming substances, either because of their absence, or because of their inability to lower the surface tension of the oil to a degree sufficient to permit the evolution of free gas.

Several experiments were performed in which the oil was known to be in a state of supersaturation, but no gas bubbles were produced, even after a lapse of several weeks. In one of these experiments, a small gas bubble was introduced into the reservoir and immediately thereafter, the bubble began to grow by diffusion of gas from the surrounding supersaturated oil. The amount of gas thus obtained represented an appreciable volume.

Practical Applications

In most fields, the energy of the free gas is considered as the principal force responsible for the production of oil.

The experiments discussed above show that the rate of evolution of gas is not solely dependent upon the saturation of the oil with gas and the pressure of the reservoir, but also upon the presence of substances that act as nuclei in the formation of gas. It is conceivable that similar reservoirs might produce at different rates, pressures being the same, only because of the difference in nature of the nuclei-forming substances.

In the case of a well producing from a perfectly clean sand, formation of gas might be impeded at some distance from the well because of the lack of nuclei-forming substances and the relatively small drop in pressure with the correspondingly small degree of supersaturation. With the same degree of supersaturation, another horizon might prove productive in the presence of suitable nuclei.

The distribution and character of foreign substances in a pay cannot be controlled by artificial means, but by proper spacing of the wells, a sufficient degree of supersaturation may be developed, thus permitting gas to come out of solution at all points of the reservoir. In order that the wells be properly

spaced, the occurrence and distribution of substances that serve as nuclei in the formation of free gas in a natural oil reservoir must be known and properly understood. It is unfortunate that our knowledge on this subject is exceedingly incomplete.

Nuclei-forming substances also affect the by-pass of gas. Their uneven distribution throughout the reservoir will cause an uneven evolution of gas, tending to develop large masses rather than small evenly disseminated bubbles. While the small gas bubbles are retained by the sand, the large gas masses have a tendency to move through the reservoir, bypassing the oil.

Small Unattached Bubbles Not Possible

In the experiment VI it was shown that the small gas bubble formed around the nucleus *a* remained attached to the nuclei-forming substance until it acquired sufficient buoyancy to cause its rise to the surface. The force of buoyancy supplied the energy necessary to compensate for the increase in interface involved in detaching the bubble from the nuclei-forming substances. This force and, therefore, the size of the bubble, is a function of the surface tension of the liquid. The fact can be easily proven by forcing gas through very fine filters submerged in a fluid. Here, the size of the small gas bubbles emanating from the filter does not depend on the size of the pore openings, but on the surface tension of the fluid. In other words, the gas bubbles will not detach themselves from the surface of the filter until their size and buoyancy effect are large enough to overcome the attraction caused by surface tension forces.

In a sand reservoir, the nuclei-forming substances, when present, usually occur along the surface of the sand grains, and the gas bubbles are consequently attached to them. Since the average size of pore space is small, it is very seldom that a bubble can acquire sufficient buoyancy to detach itself while its size is smaller than the pore space. If its size opproximates that of the pore space, its movement through the reservoir is further impeded by the resistance that the bubble offers to distortion, as was discussed in the first article of the series.

In the laboratory it is possible to develop small gas bubbles by suddenly releasing the pressure of a saturated solution. In this case, the degree of supersaturation is such that a wide variety of substances serve as gas-forming nuclei. Water, for instance, released suddenly from a tap, is cloudy because of a very large number of small air bubbles that are developed. However, in an oil pool, it is not possible to release suddenly the pressure of the entire reservoir, and thus the formation of gas masses is a selective process that eliminates the possibility of minute undetached gas bubbles being formed. Therefore, the accumulation of gas along the top of a sand cannot be attributed to the free upward movement of small gas bubbles, but to the selective growth of the gas masses.

Selective Growth of Gas Masses

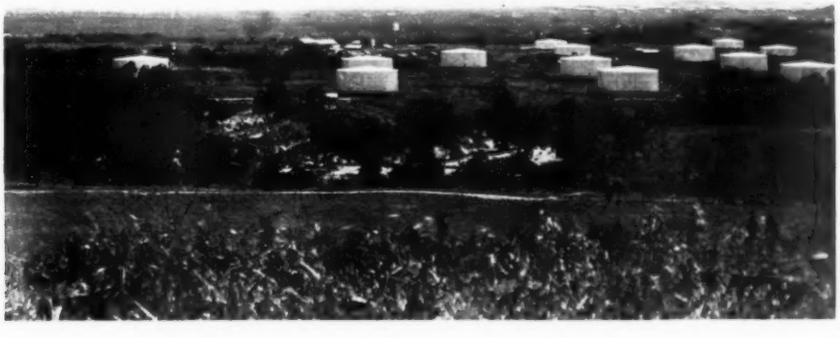
The function of nuclei in the formation of free gas has been treated above. As will be recalled, bubbles form only at selective points, which are predetermined by the nature of the nuclei-forming substances and the degree of supersaturation of the oil. The latter is affected by two distinct phenomena: first, the continued reduction in pressure of the reservoir, which tends to increase the degree of supersaturation, and second, the diffusion of gas from the oil into the already formed gas masses, which tends to decrease the degree of supersaturation. At the beginning of production, the drop in pressure causes an increase of supersaturation that cannot be compensated by the small amount of diffusion taking place into the relatively few and small masses of free gas. Consequently, there is a great tendency for new gas masses to develop around other nuclei. This tendency decreases in time, because the rate of pressure drop in the reservoir decreases, whereas the rate of diffusion of gas increases due to the following three factors:

a. The number of gas masses increases.
b. The area of each gas mass increases.
c. The concentration inside the gas mass decreases and, because the rate of diffusion is proportional to the concentration gradient, the diffusion of gas from the oil increases.

In time, the increasing rate of diffusion will equalize the effect of the drop in pressure, and from then on, the tendency will be for gas to diffuse into the already existing gas masses rather than to form new bubbles.

If the pressure in the reservoir is lowered very slowly, time is given to the gas to diffuse into already existing gas masses over greater distances, and the effect of reduced supersaturation is extended over a wider area. In this case, the tendency of gas to accumulate in large masses will be accentuated.

The growth of a gas mass is also affected by its relative position in the sand. A gas mass at the top of the sand will grow faster, and become larger than a similar mass at the bottom of the sand. In the case of the lower mass, the oil that surrounds the free gas will be of higher specific gravity than the oil immediately above, because part of its gas has diffused into the gas mass. An equilibrium of gas concentration between the two bodies of oil will eventually be established through diffusion of gas, but such a phenomenon proceeds at a very slow rate. On the other hand, the oil surrounding the upper gas mass, which is also deficient in gas, will be readily displaced by the oil below, which is of lower specific gravity, and thus, convection currents arise that play an exceedingly important part in the accumulation of free gas along the top of the sand. This phenomenon, probably more than any other single phenomenon, accounts for the tendency of gas to by-pass. This tendency can be overcome only through a very wide distribution of small, evenly disseminated gas bubbles in which case the action of convection currents is localized around each individual gas mass.



Deep Sea Drilling on

By WALLACE
Petroleum Engineer

UNLIKE other off-shore locations that have been drilled in the Pacific Ocean, the Indian Petroleum Corporation is now putting down a well at an isolated point 2700 feet from shore that is in no way connected with the land. To conduct the operations an island of steel first had to be erected; and in constructing this island due consideration had to be taken of derrick loads, equipment lay-out and the necessary facilities for drilling operations. These factors presented a problem that required accurate construction methods to provide against the hazards arising from a derrick floor built on piles 62 feet above the ocean floor and above which extended a derrick for more than another 100 feet.

The well is located in the Rincon field and on a state tideland permit which extends for about 4000 feet into the ocean. Four other wells have been drilled on similar permits in this field but all have been connected to the mainland by piers. The most seaward of these is about 1700 feet from the island location and its pier, owned by the General Petroleum Corporation, is the base of operations for the Indian well. The depths of both the mainland and the ocean wells are approximately 3000 feet but the production from the latter has averaged consistently higher than that from the land wells. It is estimated by the operating company that the structural high is even farther out than at any of the existing wells and the isolated location now being drilled is about on the top. Should such be the case the Indian well can be expected to equal, if not better, the production from any of the present wells in the field. It was felt, however, that the construction of an island instead of the much more expensive extension of the pier would be more economical for the drilling of the first well on this permit and in accordance with this view the design and construction of the island was turned over to the Robinson-Roberts Company, construction engineers, of Los Angeles.

The design of the substructure on which the derrick and the equipment have to rest required primarily the accurate spacing of the piling and the provision that the location of each pile would be maintained during its driving. In no other way could a well foundation be assured that would properly withstand the heavy wave action or meet the various stresses that would be applied. The first thing to consider, however, was a method for driving the piles since the barge used in connection with the work would have pitched and rolled too much to allow the careful driving of a pile even if it could be spotted properly.

To accomplish this, four towers of structural steel were built and hauled out on the barge to the location. Each of these was supported on corner legs 60 feet long and made of 10-inch 30-lb. "H" columns. These legs were 20 feet apart and made individual platforms which, when set up at the edge of where the island was to be, provided a platform nearly 45 feet square. On this temporary structure was set the pile driver, hoisting engine, gins and other necessary equipment. The barge had, of course, been moored before the four temporary platforms were erected and no difficulty arose in placing them, since they had been electric welded into complete units before being taken to the location.

The general design of the substructure immediately below the derrick and furnishing the foundation for it, called for four piles below each leg and a central structural member of eight piles around the caisson, thus providing a five-point pier. All the piles were 10-inch "H" columns and were driven into the shale which underlies the sand to penetrate about eight feet below the ocean floor before refusal. The arrangement is clearly seen in the accompanying drawings, while the portion of the structure above the water is shown in the photographs that were taken on the day the well was spudded in.

The four "H"-beam piles supporting each leg were cross-connected by structural members to form a compound column as was also the central ring of "H"-beam piles around the caisson. These five compound columns were inter-connected by other structural members to act as ties and thus unify the five-point pier which was designed to take the entire weight imposed by the derrick and drilling operations.

Suspended from and carried by the central ring of piles was a tank which acts as a sump for drilling mud and oil and

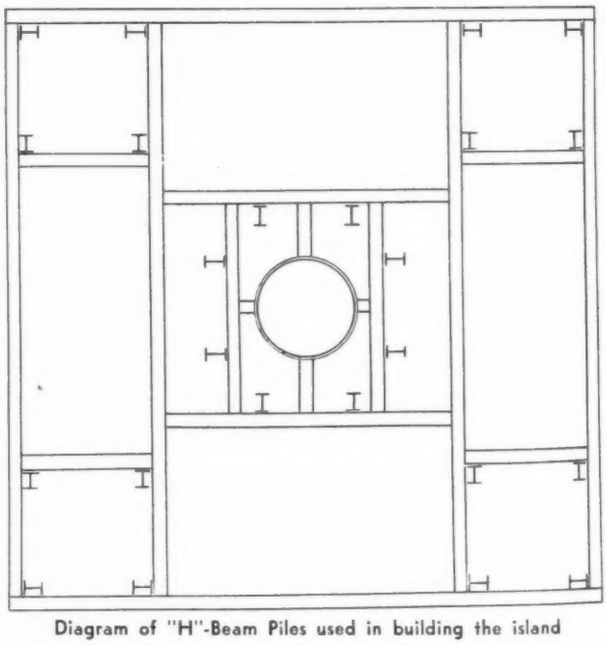


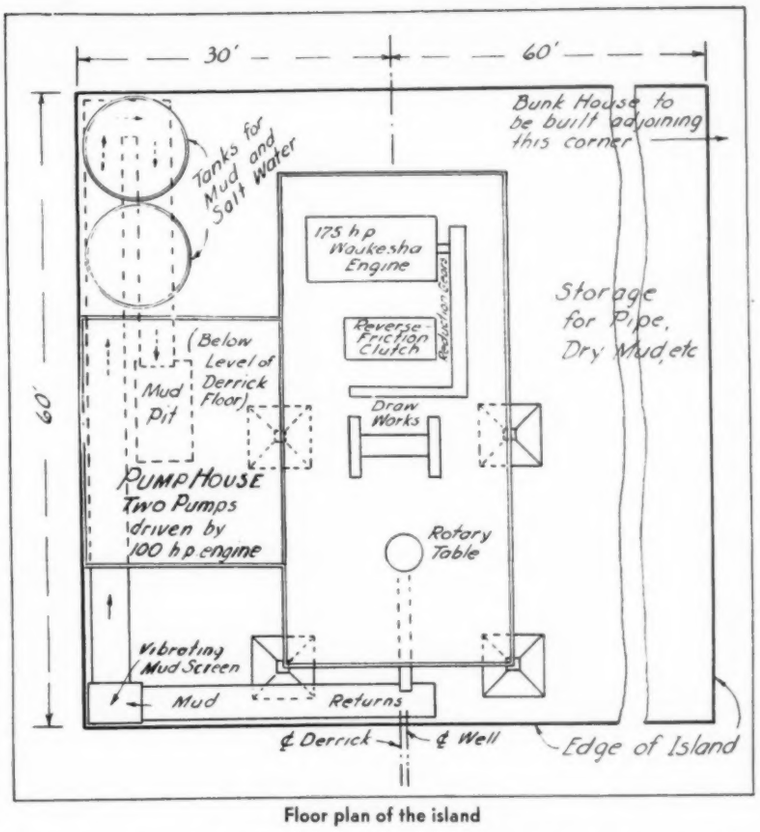
Diagram of "H"-Beam Piles used in building the island

on an Island of Steel

A. SAWDON
Los Angeles, Calif.

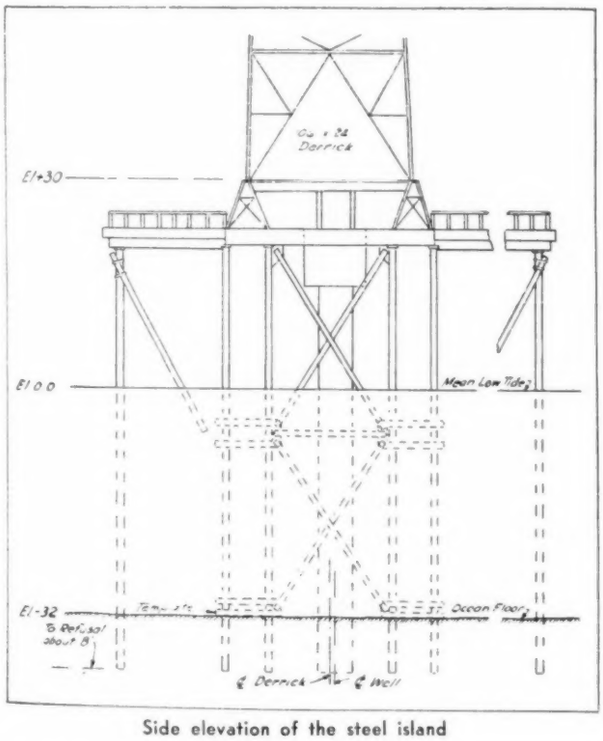
also the cellar for the well. The caisson, of course, extends from the derrick floor down into the sand and it is around this that the above tank is centered. The caisson itself did not have to be driven since it rocked its way into the formation before it was completely tied into position at the top. Through this was run the conductor pipe, which was cemented. All steel construction work above the water level was electrically welded and the little that was necessary below was clamped and bolted.

Of first importance, as mentioned above, was the accurate location of the piles for the derrick and well foundation—and the keeping of them in their proper position during driving. Several schemes for securing the desired results were conceived but it was finally decided that the use of a template would be the best. Such a template was therefore made up of structural steel with its members electrically welded, as shown in the accompanying illustration. The exact location of each pile was designated on the template, which was lowered to the floor of the ocean by the derrick barge and then aligned and leveled up by a diver.



Floor plan of the island

During the driving of the "H"-beam piles, each one was stabbed in its proper place by a diver. With the 24 which made up the well foundation pier being driven to refusal, symmetry was secured and the template left on the ocean floor to become part of the tie-in structure. A lower clamp for the sway bracing was made for each compound corner column and fitted over the four piles, making up the column with 6-inch x ¾-inch steel plates bent to encompass each pile. Gusset plates with holes for pin connections to diagonals were welded and fitted to each clamp and the clamps then lowered to the surface of the water, where diagonals of the lower bay were attached. A central clamp was then made up with gusset plates for the diagonal attachments; and with the attachments made, a piece similar to the template was thus constructed and dropped to the bottom.



Side elevation of the steel island

An intermediate clamp of similar design was then placed at about 30 feet above the ocean floor with cross bracing and sway bracing set as shown in the drawing. Two guides were in place when the caisson was set and, as stated above, it was allowed to rock itself into the formation before it was plumbed and fastened. The conductor pipe was then driven and cemented.

Two steel plates were fastened on each pile by the diver, who bolted them just above the lower clamp. The bracing was then placed in tension by means of turnbuckles. To overcome the tendency to twist should eccentricity be thrown into a corner column, a steel diaphragm was welded over the entire rig area to form a web. This diaphragm was also designed as a subfloor below the derrick floor and besides acting further as a drain pan, it serves to prevent the lifting up of the floor by any high seas.

The entire platform which makes up the steel island is 60 by 90 feet and the area surrounding the derrick floor is supported by "H'-beam piles like those used for the well foundation described above. The elevation of the derrick floor is 30 feet above mean low tide, but that of the rest of the platform is seven feet below this. The derrick is an Emsco, 106 feet high with a 24-ft. base; and the top is thus 168 feet above the ocean floor.

The drawworks and table are powered by a 175-hp. Waukesha gasoline engine through reduction gears. Two Gardner-Denver mud pumps are set in a pump house on the main platform level below the derrick floor. These are driven by a 100-hp. Waukesha engine by a Texrope drive. Other auxiliary engines include a 10-hp. Fairbanks-Morse used for handling water and pumping away mud and another 100-hp. Waukesha stand-by unit. All the larger gasoline engines have a vacuum feed with the fuel supply located in tanks under the opposite end of the derrick floor. The mud returns pass through a Link Belt vibrating screen, which is also operated by a gasoline engine.

Power Factor and Its Economic Significance in Electric Power Systems

EFFICIENT operation of machinery is a factor which is always given serious consideration by executives and superintendents of manufacturing plants. This is especially true at this time, because of the smaller margins of profits, and reduced volumes of production. It is, therefore, pertinent that any subject bearing upon possible increased efficiency and reduced operating costs be discussed. The subject of this article presents a problem which, in the past, has been given little consideration, but which, in many instances, has a direct bearing on the efficiency of the electric power system. This apparent indifference is often due to lack of knowledge regarding the subject.

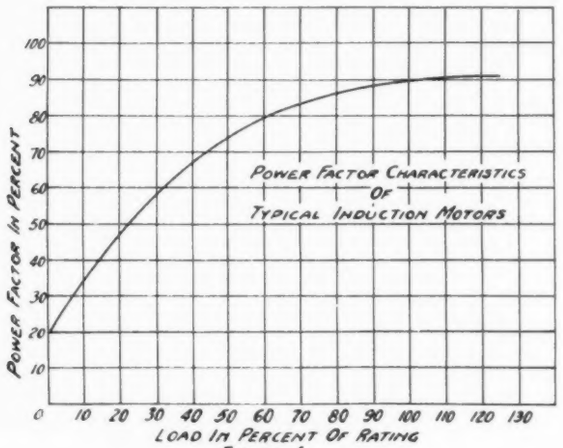


FIGURE 1

Much has been written on the subject of "Power Factor." These articles usually use such expressions as "Cosine of an Angle," "Wattless Current," etc., thus introducing an air of mystery. As a result, the layman and many engineers do not have a clear understanding of this term and the conditions involved. The object of this article is to state in clear, non-technical terms the exact meaning of "Power Factor"; to point out the causes and effects of low power factor, with remedies for them; and to explain the economic losses which are involved.

In the operation of alternating current electric machinery, two factors are involved, which, without going into the technical details and explanations, we shall term "Power Current" and "Magnetizing Current." The power current is that which, when delivered to an electric motor or other device, will produce actual mechanical work. The magnetizing current is required in certain portions of the machine to make a magnet of that part, and is essential to its operation. In measuring the current consumption of an alternating current motor, these two values are inseparable, and when this value is multiplied by the "Voltage" and other factors, it is given the term "Apparent Power." The watt-hour meter used to measure the power consumed by this motor records only the power current; hence, its reading is called the "Actual Power." The ratio of the "Actual Power" to the "Apparent Power" is called the "Power Factor." In other words, power factor is a multiplier which applied to the apparent power will give the actual power; also, when applied to the total current used by the motor, this multiplier will give the power current, from which the magnetizing current may be determined. Magnetizing current is necesssary for the operation of all alternating current motors (except synchronous type), transformers, and long transmission lines. While it may be termed a "necessary evil," by careful design of equipment and correct applications, magnetizing current may be kept to a minimum. With the definite understanding that "Power Factor" is a multiplier; that this multiplier may be applied to the total current in an alternating current circuit to determine the "Power Current" and the "Magnetizing Current"; and that this "Magnetizing Current," while essential to the operation of the machine, should be kept to a minimum value—we will proceed with a discussion of the causes of excess magnetizing current.

In the operation of an electric motor, the amount of magnetizing current required is practically a constant quantity, while the power current is almost directly proportional to the horsepower output of the machine. It is apparent, therefore, that in a partially loaded motor the ratio of the magnetizing current to the power current is very much greater than if the motor were fully loaded. The proper selection of motors is, therefore, most essential in order to maintain a low ratio between these two current values, and thus to keep the power factor high. In other words, the actual horsepower of the load should be determined as closely as possible, and a motor selected which under normal conditions would be fully loaded. Of course, there are conditions where motors are subject to widely fluctuating loads, where it is necessary to provide equipment which will compensate for the low power factor conditions created; this will be discussed in another section. The curve shown in Figure 1 will give a definite idea of the reduction in power factor due to partial load on a standard-type induction motor.

The same conditions obtain in partially loaded transformers; and, in addition, this excessive current causes other complications, which aggravate the operating conditions, even more than in motors. For economic operation it is, therefore, essential that all equipment be operated as closely to its rated capacity as possible. This will have a tendency to minimize the amount of magnetizing current in the alternating cur-

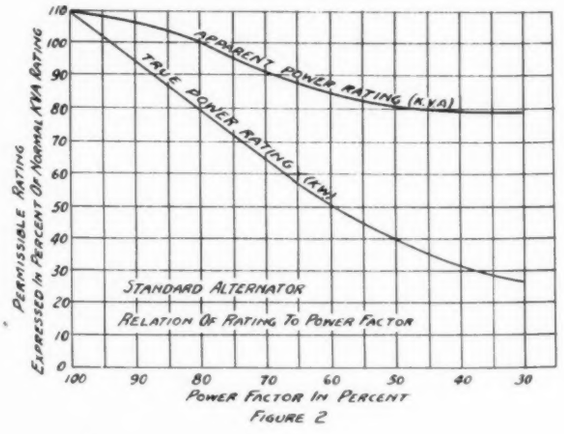


FIGURE 2

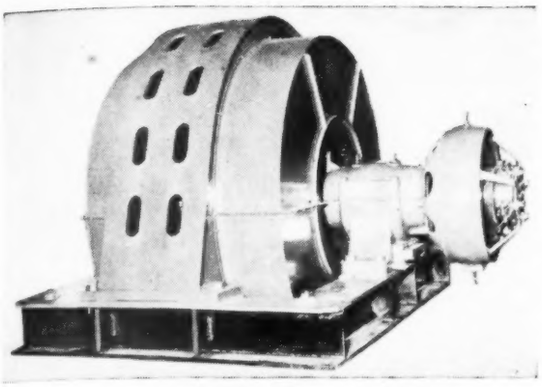


Figure 3. A 2000 KVA Synchronous Condenser

rent circuit, but cannot entirely eliminate it, for a certain amount is essential to the operation of the equipment.

From the above explanation, we understand that this magnetizing current is essential to the operation of alternating current equipment; but for economic reasons it should be reduced to a minimum value. In this section, we shall point out the detrimental effects on equipment and the losses incident to the excess amounts of magnetizing current. While this magnetizing current is not registered in a watt-hour meter, the losses which are produced by the transmitting of this excess current over the transmission and distribution lines and through generators, transformers, and motors, and which is actual power, is registered in the meter and must be paid for by the consumer at the usual power rate. In addition to this, the circulation of this excess magnetizing current through the lines and equipment causes heating, which means a reduction in capacities, necessitating either larger equipment or the ability to do less productive work.

This reduction in capacity is very apparent in the alternating current generator, for as the ratio between apparent power and actual power becomes greater, the ability of the machine to produce power current becomes proportionately less. When this ratio becomes excessively large other factors are involved, such as the inability of the generator to maintain its rated voltage. This reduction in capacity is clearly shown in Figure 2, where the upper curve represents the apparent power and the lower curve the true power, under various power factor conditions. Reduction in capacity of generators represents an economic loss for two reasons: less power output, which means greater investment in proportion to the useful work which the machine is capable of doing; and greater losses within the machine, which requires more fuel in the prime mover to produce the same amount of useful work. The effect of reduced power factor on the efficiency of a standard type and size of alternating current generator is clearly shown in the following table:

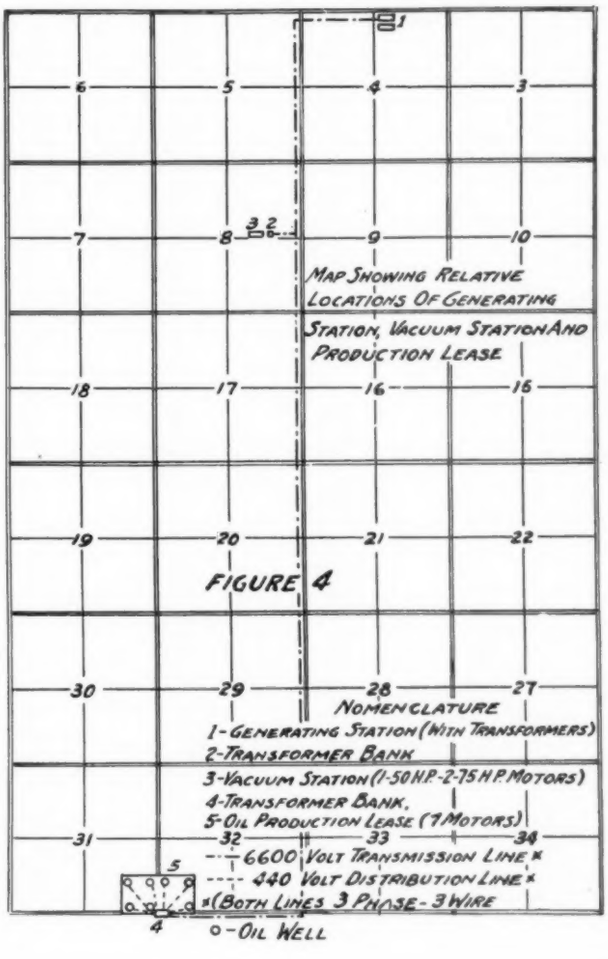
TABLE 1

Power Factor	100%	90%	80%	70%	60%	50%
Efficiency	92.2%	91.7%	91.1%	90.4%	88.6%	88.4%

It is very apparent, therefore, that for the economical operation of an alternating current generator, the magnetizing current in the circuit which it serves should be kept to a minimum. It has been pointed out that for a given power current, the magnetizing current is a direct ratio of the power factor. In other words, in a circuit the power factor of which is 50 per cent, the magnetizing current is equal to the power current, and the wires are required to carry just twice the amount of current that would be necessary if the power factor were 100 per cent. It is a well known fact that the losses in transmitting current over a given line are in proportion to the square of the current values. Applying the above example, wherein the current values are doubled with a power factor of 50 per cent, the losses in transmission would in this case be four times those in which the power factor was 100 per cent. It is readily seen, therefore, that, with the increase in magnetizing current in transmission lines, the line losses increase very rapidly; not in direct ratio, but in proportion to the square of the excess current.

The losses outlined above, in the transmission and distribution lines, apply to transformers. In addition, another factor is involved, which is very important in the successful and satisfactory operation of electric motors. The percentage which the voltage of a transformer increases from full load to the condition when the load is removed is called the "Regulation" of the transformer. This property is very materially affected by the excess current of the low power factor, which results in reduced power delivery to the motors. Motors operating under this condition of poor transformer regulation do not have sufficient starting capacities, operate at less than their normal speed, and heat excessively, and thus have less mechanical output. It is readily seen, therefore, that transformers operating under a condition of excessively low power factor produce in turn a very unsatisfactory economic condition for the other equipment connected to the electric lines.

In a previous paragraph it was stated that, while magnetizing current cannot be entirely eliminated from the alternating current system, it can be very materially reduced. It is the problem, therefore, of the manufacturer of alternating current motors so to design them as to require a minimum of magnetizing current; and of the user to select motor equipment which will best meet his needs, and which he may keep as fully loaded as possible. While it is impossible to eliminate magnetizing current from the system, it is possible to provide sources of supply for this current which are



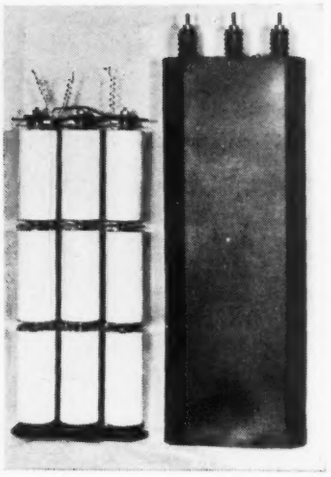


Figure 5
Construction and container for one type of Capacitor

adjacent to, or near the motors requiring it and thus to keep a portion of this excess current from circulating over a large distribution and transmission system, through transformers, and to the generator. This may be accomplished by several types of equipment, namely: synchronous motors, synchronous condensers, and static condensers, called "Capacitors."

The synchronous motor is similar in construction and design to the alternating current generator. In its operation it receives electric current and produces mechanical power. This type of motor is provided with a small direct current generator, which furnishes power to magnetize the "field"; hence it does not need to secure this portion of its power from the alternating current power supply. The power factor of this machine under normal operating conditions is, therefore, 100 per cent, since all of the alternating current supplied is used in producing mechanical power. If a synchronous motor is connected in an alternating current circuit supplying power to induction motors, it can be made to produce some of the magnetizing current required for the induction motors, by supplying an excess current from the direct current generator to the fields of the synchronous machine. It is possible, therefore, to locate one or more of these synchronous motors in a plant having a number of induction motors and by supplying most of the magnetizing current required, thus to prevent this excess current from circulating through the transformers, and over the transmission lines to the generator for the system, which may be many miles away. This synchronous motor is also caused to do work with a per cent of its total capacity, by connecting it to a machine to be driven. This method of correcting low power factor is found to be very economical where machines, such as air compressors requiring motors of large capacity operating almost continuously are used.

The synchronous condenser is a synchronous motor which is not required to do mechanical work, but is merely connected to the electric system and said to "float on the line." An excess of direct current is delivered to the "field" as in the synchronous motor operation, thus producing the necessary magnetizing current for the numerous small motors of the system. This method of power factor correction is satisfactory and successful, although not as efficient as other methods, on account of a considerable amount of loss in the operation of the machine.

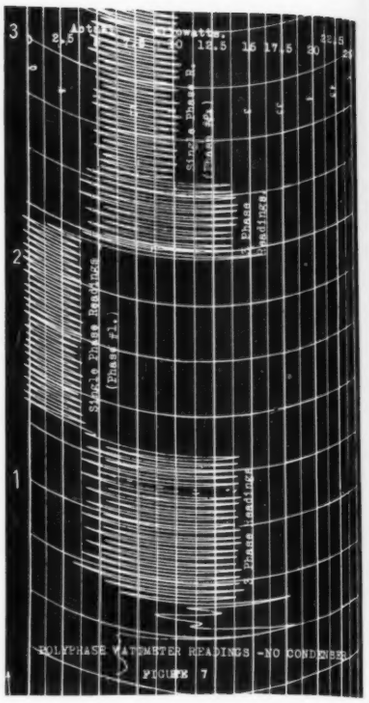


Figure 7

The simplest and most successful method of power factor correction is the capacitor. This equipment consists of alternate layers of conductors and insulators, as in any standard condenser, usually immersed in oil, and installed in a tank or metal container. One of the newer types of capacitors consists of units, cylindrical in shape, containing two conductors of aluminum sheets separated by tissue paper insulators. The rolls are mounted in racks, connected in proper groups for voltage and capacity, and installed in a tank filled with a high-grade insulating oil. Figure 3 shows the construction and design of a capacitor of this type.

Capacitors may be connected in groups to a system or individually to the motor requiring the magnetizing current. In either care, no attention is required after installation. The ideal method of installation is by direct connection to the motor terminals, for the distribution lines are then required to carry practically no magnetizing current, and the maximum economic benefits are obtained. If this method is not feasible, larger capacitor units may be installed to take care of the magnetizing current for a group of motors, or if necessary, a unit of sufficient capacity used to take care of an entire plant.

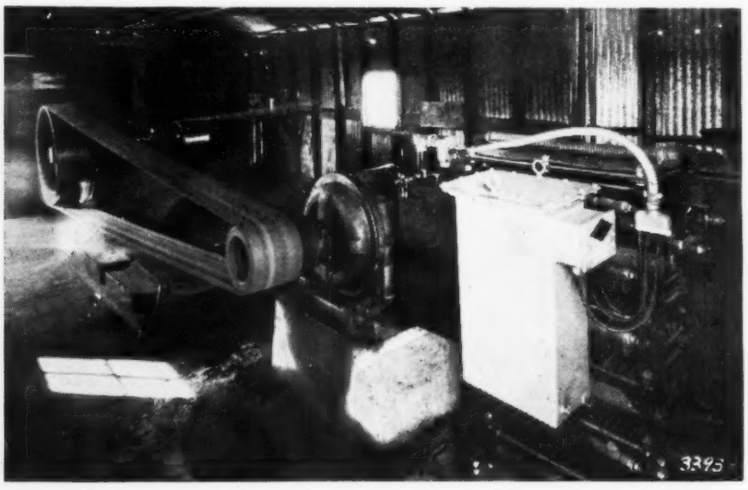


Figure 6. Typical example of Capacitor connected to individual motor terminals

From the above discussion, we find that, for economic operation of an alternating current system, the following conditions should be met as closely as possible:

First: Select motors of as high power factor as possible, other conditions being equal.

Second: Select motors which will be fully loaded a majority of the operating time, thus reducing to a minimum the amount of magnetizing current required for the system.

Third: If the power factor is then low and cannot otherwise be corrected, install the equipment which best meets the operating conditions, in as close proximity as possible to the motors requiring the magnetizing current, and which will produce most of this magnetizing current.

If the facts and conditions pointed out in this article were merely theoretical, and were of no practical importance, they would have no value in

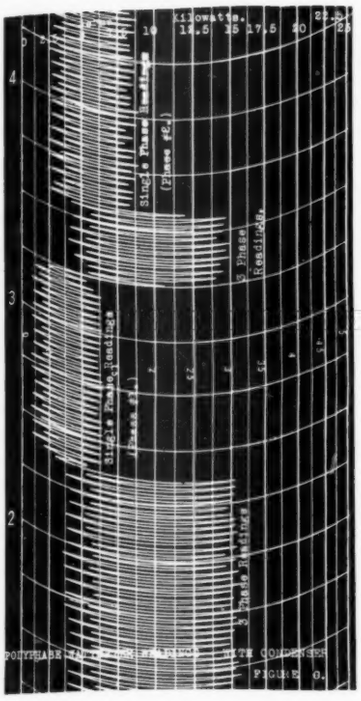


Figure 8

the commercial world. The fact is that each of the losses mentioned is represented in the monthly power bills and other actual cost items. It has been the general impression that the subject of power factor was merely a theoretical one, which could not be verified in fact, and for this reason, generally speaking, very little serious thought has been given to the subject. Educational campaigns, however, conducted by certain manufacturers, and greater competition in all lines of commercial enterprises requiring lower operating costs, are rapidly changing this condition.

In order to verify the operating conditions and conclusions outlined in the previous paragraphs, the following actual tests, with conditions, corrections and financial savings, covering a property of one of the large oil companies in the Mid-Continent field, is given in detail.

This company installed an electric generating station at one of its gasoline plants. The equipment consists of a 312 KVA, 2300-volt 3-phase, 60-cycle alternating current generator, direct connected to a gas engine, with necessary switchboard and control equipment. A bank of transformers was also installed inside the station to raise the voltage from 2300 to 6600, in order to transmit the power to a vacuum plant, located approximately three miles distant, and an oil producing property located an additional six miles away. The load at the vacuum plant consists of one 50 and two 75-hp., 2300-volt induction motors, served by a bank of 6600 to 2300-volt transformers, all of which are approximately fully loaded. The power factor at this station is evidently satisfactory, as the motors are approximately fully loaded. At the production lease are located seven oil well pumping motors, rated 15 and 30-hp., slip ring, variable speed, and a bank of transformers to reduce the voltage from 6600 to 440. These double horsepower rated motors have a very low inherent power factor, and as they are only partially loaded, the average power factor at the lease was 65 per cent.

When this system was put in operation, it was found that because of the low power factor, it was necessary to use the full capacity of the direct current generator ("exciter") in order to maintain the rated voltage of the alternating current generator; and also that the generators both became excessively hot, even requiring a large fan to keep them cool, and thus prevent burning out the windings and causing a shut-down. At the lease it was found necessary to connect the transformers on the highest taps, thus delivering to the oil well pumping motors the highest possible voltage. Figure 4 shows the relative locations of the generating plant, vacuum station and production lease, with lines and transformers.

In order to relieve these conditions, the installation of 7½ KVA capacity, 440-volt capacitors at each oil well pumping motor was considered. However, before authorization for the expenditure could be secured, it was necessary to make a preliminary report as to the results which might be expected, and also the dollars and cents saving which would accrue from the reduction in line, transformer and generator losses. In order to determine these results, one capacitor was installed at a pumping motor and tests made with and without the capacitor connected in the circuit. Tests were also made at the generating station to determine power factor conditions. From these tests, calculations were made, as contained in the following report.

This test was made on one of the oil well pumping motors rated: 15/35 hp., 600/1200 revolutions, 3-phase, 60 cycles, slip ring type, variable speed, with drum type controller.

Without Capacitor Connected to Motor Terminals

Three-phase kilowatts from chart,* average	10
Amperes from indicating instrument, average	22.5
Volts from indicating instrument, average	448.0
Product of amperes by volts by $\sqrt{3}$ (KVA)	17.40
Power factor, calculated (kilowatts ÷ KVA)	57.5%
Single phase kilowatts from chart,* average	1.60
Single phase kilowatts from chart,* average	8.75
Power factor from ratio curve**	62%

*See Figure 7 for chart made by curve drawing wattmeter, during test. The irregular curves are due to the fluctuating load, because of the up and down motion of the pump rod.

With 7½ KVA Capacitor Connected to the Motor Terminals

Three-phase kilowatts from chart,* average	10.00
Amperes from indicating instrument, average	15.75
Volts from indicating instrument, average	454.00
Product of amperes by volts by $\sqrt{3}$ (termed KVA)	12.39
Power factor, calculated, (kilowatts ÷ KVA)	81%
Single phase kilowatts from chart*	6.50
Single phase kilowatts from chart*	3.55
Power factor from ratio curve**	87%

*See Figure 8 for chart made by curve drawing wattmeter during test. The irregular curves are due to the fluctuating load, because of the up and down motion of the pump rod.

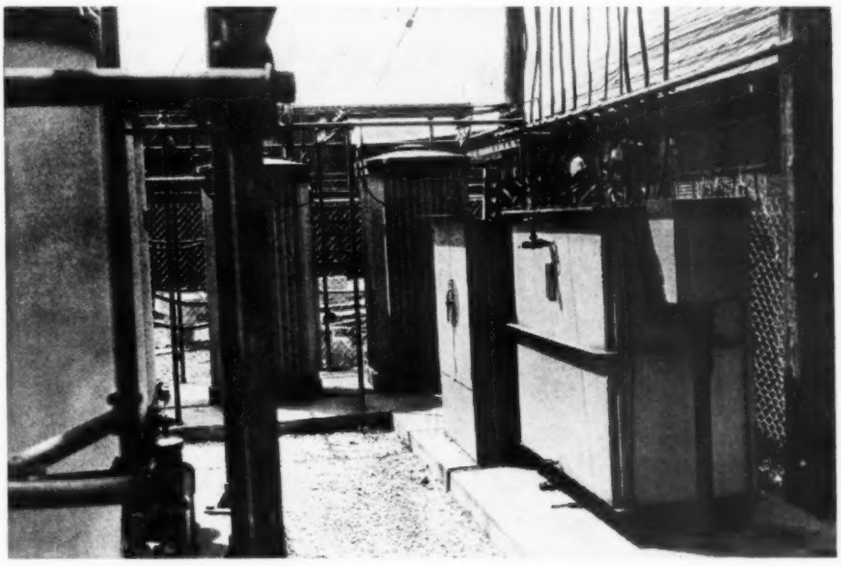


Figure 9. Example of group correction of power factor. Capacitor connected in transformer bank for correction of entire plant

From the above tests it is seen that the power factor of each motor is improved from 62 to 87 per cent, which means that the system is improved proportionately. Based upon the above tests the following calculations were made:

High-Tension Transmission Lines (as shown in Figure 4)

Line loss at 62% Power Factor, (with no capacitors in use)	8.14 KW
Line loss at 87% Power Factor, (with 7 capacitors in use)	3.37 KW
Saving in line loss due to higher power factor	4.77 KW

Distribution Lines on Lease (as shown in Figure 4)

Line loss at 62% Power Factor, (with no capacitors in use)	13.62 KW
Line loss at 87% Power Factor, (with 7 capacitors in use)	6.00 KW
Saving in line loss due to higher Power Factor	7.62 KW
Total saving in distribution and transmission lines	12.39 KW

Assuming 85 per cent load factor, (the ratio of the actual operating hours to the total hours in a year), or 7438 pumping hours per year, the total power saved would be 7438 × 12.39, which equals 92,157 kw-hr. Based upon an actual generating cost at this plant of $.0083 per kw-hr., the annual saving in transmission and distribution line losses would be $764.90.

Generating Equipment

The efficiency of this alternating current generator at 80 per cent power factor is 90 per cent. During this test it was determined that the power factor of the electric system at the generating station was 70 per cent. At this power factor the efficiency of the generator is decreased to 87 per cent. After the seven capacitors are installed at the producing lease, the power factor is expected to be improved to 86 per cent. (After the capacitor installation was made, a test at the generating station verified this fact). The generator efficiency at 86 per cent power factor is raised to 91.5 per cent. A saving of 4 per cent is therefore effected in the generator losses by increasing the power factor of the system at the generating station from 70 to 86 per cent. Based upon the capacity of this generator, which is 250 kw, and which is approximately fully loaded, the saving effected per year, (at a load factor of 85 per cent), amounts to 42,048 kw-hr., which at $.0083 per kw-hr will save annually $349.00.

Transformers at Production Lease

Based upon the characteristics of these transformers, the following estimates of losses wthin the equipments at the different power factors have been made:

Estimated loss at 62% Power Factor, (no capacitors in use)	1.478 kw
Estimated loss at 87% Power Factor (7 capacitors in use)	.727 kw
Saving due to increased Power Factor	.751 kw

Based upon 85 per cent load factor, (as previously explained), or 7438 pumping hours per year, the saving effected would amount to .751 × 7438, or 5,586 kw-hr, which at $.0083 per kw-hr, would amount to $46.36.

The term "regulation" as applied to transformers has been explained in a previous paragraph. In this specific instance the regulation of these transformers has been improved from 3.60 per cent at 62 per cent power factor, to 2.7 per cent at 87 per cent power factor. This means that more power is delivered to the motors by the transformers after the power factor has been improved, than before; resulting in more starting capacity, higher operating speed and less heating of the motors.

Summary of Savings Effected

The following is a summary of the annual savings effected by the installation of 7½ kva individual capacitors at each of the seven oil well pumping motors:

Transmission Lines	$ 764.90
Generating Equipment	349.00
Transformers	46.36
Total Annual Savings	$1,160.26

The total cost of the seven capacitors, delivered and installed at the motors, was approximately $1,800.00. The above savings, therefore, would pay out the original investment in approximately 18 months.

After the installation of the capacitors was completed, the following improvements in operating conditions were noted:

1. It was not necessary to furnish as much direct current to the alternating current generator, to maintain the rated voltage of the machine.

2. All tendency toward excessive heating of both the alternating current and direct current generator disappeared, even though the machines were carrying their full rated load.

3. It was necessary to move the taps on the transformers at the producing lease to the lowest possible value to prevent excess voltage being delivered to the motors. This proves that the "regulation" of the transformers had been improved as anticipated.

4. The instruments indicated that the excessive magnetizing current had been removed from the system.

The results, both in improved operating conditions and in actual savings effected by this installation of capacitors, were far greater than expected, for many factors are involved in low power factor conditions which cannot be anticipated.

The above test and report covers the conditions incident to isolated plant operation, wherein the producer is also the user of the electric power. The same conditions in general would obtain with a user purchasing power from a public utility company. The losses in transmission and distribution lines and transformers would register in the power company's watthour meter, and would be paid for at the power rate. A large number of utility companies, appreciating the value of high power factor to their equipments and systems, have adopted power factor rates in their schedules. This bonus and penalty feature in the power rate would correspond to the generator savings contained in the above report, and serve as an inducement for the purchaser of power to maintain as high power factor as possible.

This is an age of high efficiency, large production and relatively low operating costs. For any industry to survive it is necessary that every item of cost be carefully checked, and all "leaks" avoided. For this reason such a problem as this subject is creating more real interest than ever before among executives, superintendents and engineers. The object of this article is to point out the fact that "power factor" is not a mere theoretical term, but one just as real and costly as "kilowatts" and that both are contained in the monthly electric power costs. Also that low power factor in any system is an avoidable condition, and one that may be easily and inexpensively corrected, resulting in reduced power costs and much improved operating conditions.

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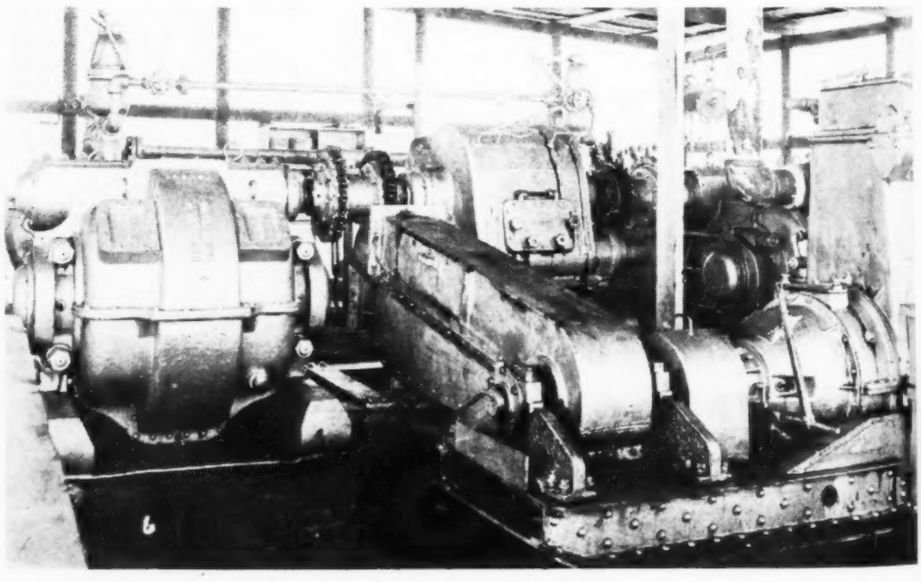
Stanolind Oil and Gas Company's Irion County wildcat well, Williams No. 1, near Mertzon, Texas

High Speed Diesel-Powered Rotary on Irion County Wildcat

By K. C. SCLATER

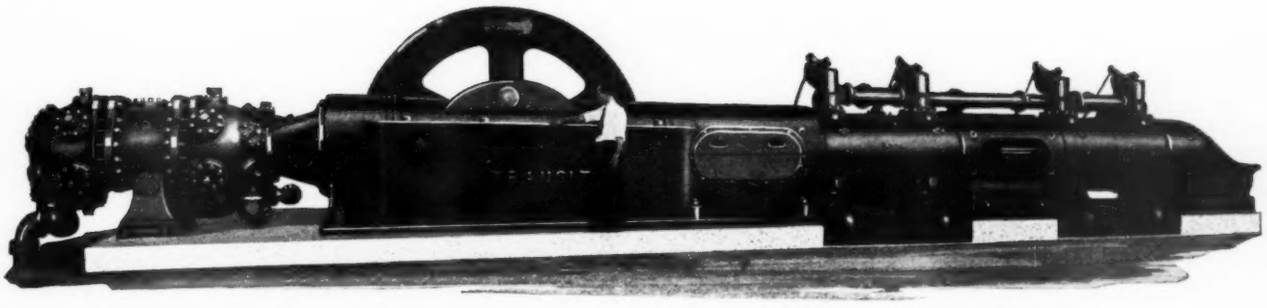
WHEN a wildcat well is started, very often there is little or no information available about the exact character of the formations to be penetrated, how they will drill and what obstacles they will place in the path of the drilling contractor before the desired depth is reached. So to drill deep wells economically, especially wildcats in isolated regions, demands equipment that is dependable and sturdy; equipment upon which the utmost reliance can be placed as to its satisfactory operation throughout the extreme ranges of duty usually encountered in deep drilling. Aside from drilling difficulties, two important items that enter into drilling costs on deep wildcat wells, are fuel and water. The availability of these at the well location will influence the choice of power to be used. Thus it is that drilling machinery of the most modern design, driven by power units of a highly efficient type, is often to be found on wildcat wells in the most remote localities. In Irion County, Texas, for example, a modern heavy-duty rotary, powered with high-speed Diesel engines, is to be found on the Stanolind Oil and Gas Company's Williams No. 1, a wildcat well about 70 miles east of the Big Lake field.

This well has a checkered history. It was drilled with cable tools to 6795 feet. At this depth caving trouble in the hole became so serious that progress on the well was almost completely halted. At this stage a rotary was installed on the well. Several fishing jobs and countless difficulties of one kind or



The power take-off from the engine and the power drive to the mud pumps. Note in the upper part of the picture the emergency line for fire hose connected into and extending between the air cylinders on the discharge of the mud pumps

Built Solid and Strong *for* Maximum Rigidity

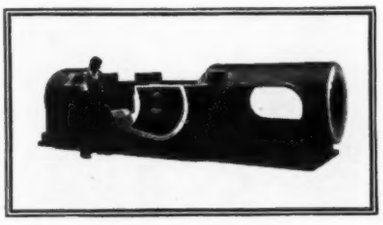


TRANSIT TWIN TANDEM - 1200 H. P. - FOUR CYCLE - DOUBLE ACTING
DIRECT CONNECTED - OPPOSED TYPE - GAS ENGINE COMPRESSOR

THE TRANSIT 1200 horse power gas engine gas compressor has been carefully designed and built for maximum strength and rigidity. It is not a mass of iron or steel hurriedly designed and thrown together.

There are no novelties. Only those constructions which have been proved by many years of experience in the building of gas engines have been retained.

The main frame is the backbone of an engine. In this engine it is cast in one piece. The frame is of the barrel type construction with a heavy box section for the crank pit. This combination of barrel and box construction insures great strength and rigidity. The heavy box section in which the main bearings are located is carried well above the center line of the cylinders for additional strength and rigidity. The weakening effect of the gap in the frame is entirely eliminated by a tie bolt.



MAIN FRAME

To take care of the load transmitted by the power cylinders with the least possible moment on the shaft, the bearings are kept short and located as near the center line of the cylinders as is possible. The main bearings are of the quarter box type and are 16-½ inches in diameter.

The main shaft is 16-½ inches in diameter throughout its entire length.

As set forth above, and in every detail, great strength and rigidity is the rule—there are no exceptions.

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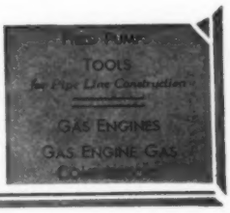


another arising from caving trouble in the well retarded drilling progress to a serious extent even after the rotary was put into use.

Eventually, however, a 7¾-inch hole was carried to a depth of 7425 feet. Evidence of the difficulties encountered in getting the hole in good condition with the rotary is the fact that it took 1408 hours to drill this 630 feet of 7¾-inch hole. This was the actual number of hours the drilling rig was in operation and includes the time taken in running in and pulling out, but does not include shut-down time waiting for materials, mixing mud and such like.

In drilling the 630 feet of 7¾-inch hole, 4½-inch Spang Chalfant drill pipe, strung up with six lines on a 3-speed drawworks, was used. The mud pumps, which had 6½-inch by 18-inch liners, were run normally at 36 strokes per minute. At this speed the working pressure was from 850 to 1000 lb. per sq. inch, but occasionally was increased to a maximum of 2600 lb. per sq. inch.

It was while at this depth (7425 feet) that a fire at the well destroyed the rotary rig almost completely. The rig was subsequently replaced with a new 4-speed Lucey drawworks, the one now on the well. Replacement of the other equipment was made with only a few minor changes and improvements, so that the general rig arrangement at present on the well is virtually the same as that before the fire occurred. That this was done by the company and the drilling contractor is evidence of the satisfactory performance of the Diesel engine powered heavy-duty rotary.

After rigging up, the hole was sidetracked from a depth of about 5900 feet and drilled in this manner to 6915 feet, at which depth drilling on the well was suspended. The well is still shut down at this writing.

A good idea of the equipment and its general arrangement can be had from the accompanying photographs, which were taken at the well after the new rig replacing the one destroyed by fire was installed.

As will be observed, the rotary is a Lucey new type A-14000-A oil-bath rotary, designed to provide a continuous bath of oil to all bearings and moving parts. No foreign matter from the well can enter the oil reservoir from below, an advantageous feature while drilling where blow-outs are likely to be encountered. The gear ratio is 4 to 1, and the table opening 26 inches. The rotary has a length overall of 106½ inches, a height overall of 26 inches, and a net weight of 11,545 pounds.

The drawworks is a Lucey type 888 4-speed jack-shaft drawworks with Timken roller bearing mounted drum-shaft and jack-shaft, and a water-cooled drum. The drum, line and jack-shafts are 8-inch diameter, and the total weight of the drawworks is 26,000 pounds.

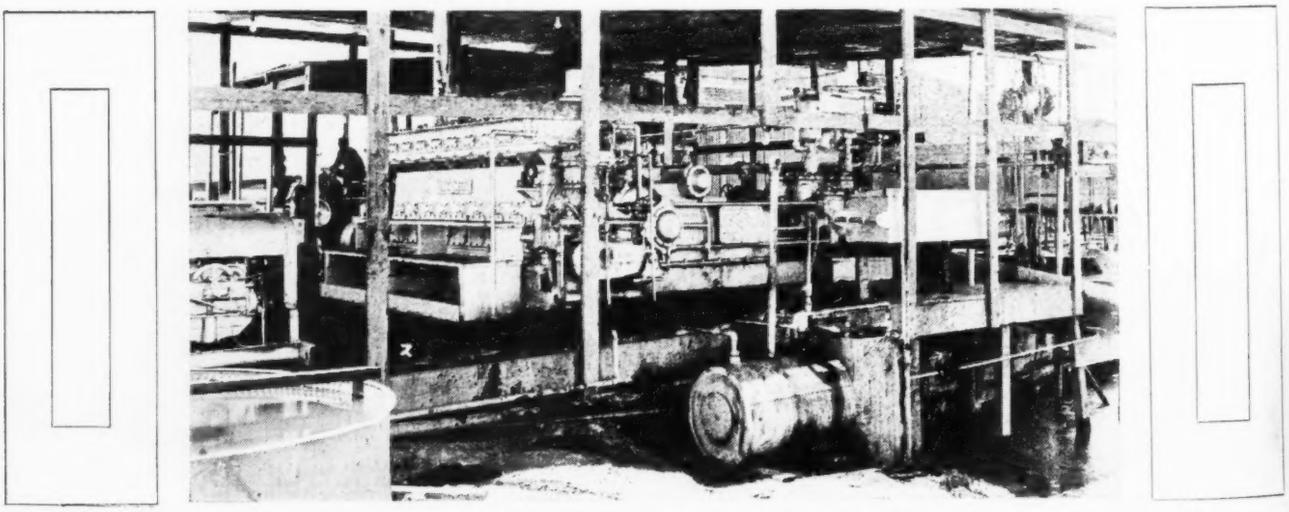
One of the most important components of this new rotary rig is the reversible clutch. It is the new improved Lucey type B-4583, designed with roller bearings for a load of 480 hp. and is operated by Twin Disc clutches both in forward and in reverse without a backband. Its use on this well has been highly successful. It is one of the few heavy-duty reverse clutches manufactured today that are eminently suitable for deep rotary drilling.

The driller's control for the drawworks engine is similar to that used on a steam rig and consists of a hand-wheel and telescoping rod. Standing in his regular position with the hand-wheel in his left hand, the driller, by turning the wheel to the right, decreases the engine speed or vice versa, and, with the hand-wheel pushed away from him and toward the jack-post, the clutch will be engaged in forward rotation and the rotary table made to turn clockwise. By pulling the hand-wheel toward him eight inches or so, the clutch will be in neutral, and if he pulls the hand-wheel and telescoping rod toward him still farther, the clutch will be engaged in the reverse position. It was found that the drillers acquired the use of this control without the slightest difficulty.

The power unit consists of two 265-hp. 600 r.p.m. Fulton type L, 8-cylinder Diesel engines mounted on steel skids with power take-offs for Diamond roller chain, and including such accessories as complete starting unit and radiator cooling The weight of each complete engine unit, excluding the radiator, is approximately 21,000 pounds.

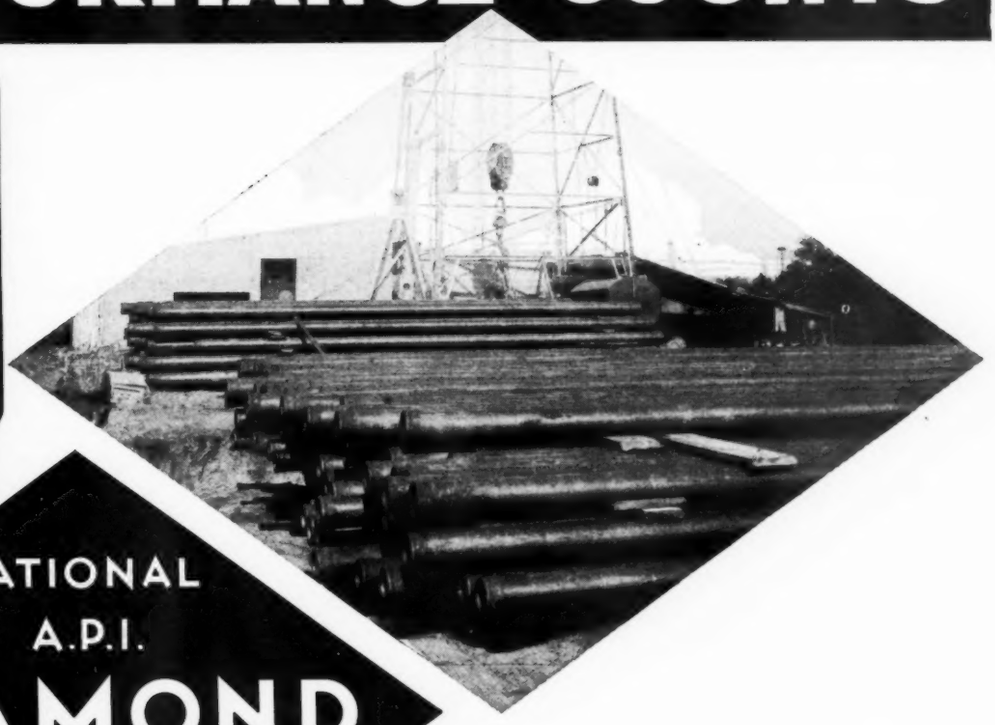
The power take-off is through a twin disc clutch from the flywheel of the engine to the shaft carrying the sprocket through a Falk flexible coupling. The sprocket is mounted between two roller bearings with the bearing supports bolted to the skids of the engine.

The mud pumps are the regular Lucey 7¾-inch by 18-inch size but equipped with 6½-inch liners. Their length overall is 14 ft. 6 inches, width overall 5 ft. 1 inch, and total weight 25,000 pounds. Although the main gear and cranks run in oil the Timken bearings are sealed so as to be oil-tight and mud-tight, independent of the inside and outside of the housing, and are lubricated through Alemite connections on the four boxes. Lubrication to the crossheads is supplied by



View of the Fulton Diesel engine that drives the mud pumps

IN EAST TEXAS AS ELSEWHERE PERFORMANCE COUNTS



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NATIONAL SEAMLESS

PIERCED FROM SOLID BILLETS - NO WELDS

the crank and main gear by means of the splash system through ports to the center section.

The gear box is an independent driving unit connecting the engine to the pumps by means of flexible couplings. Two speeds are provided by means of two trains of tool-steel spiral gears with hardened teeth. Made of forged steel, the shafts are mounted in Timken tapered roller bearings carried in a cast-steel housing. Alemite lubrication is provided for the bearings, and the gears run in oil.

On the whole, the hook-up on this rig is simple and direct. Drive chains, of the high-speed roller type manufactured by the Diamond Chain Company, from the power take-off of the engine, one to the clutch and another to the gear, are all that are required.

The reversible clutch is set five feet from the drive shaft of the drawworks and the engine five feet from the clutch, thus making a compact assembly. From the engine to the clutch the ratio is 2½ to 1, and the ratio to the gear-box is direct. From the pinion on the gear-box to the power take-off on the engine the distance is seven feet.

Every piece of equipment and machinery used on this well was put to a severe test as the drilling conditions were anything but normal, due to the fishing jobs, plugged bits and all manner of difficulties arising from the caving troubles that were encountered.

On one fishing job in particular it was found necessary to increase the pump pressure to 2600 lb. per sq. inch in order to establish circulation. As a safeguard to the equipment under such extremes of pressure a B. S. & B. blow-out head with discs of 0.040-inch thickness to relieve the pressure at 2000 lb. per sq. inch was installed on the discharge line of the mud pump. Two of these discs blew out and it was necessary to use others of 0.045-inch thickness to relieve the pressure when 2600 lb. per sq. inch was reached. If left in service too long these discs will blow out at several hundred pounds below their prescribed pressure. Pulsations of the pump at peak pressures causes fatigue of the discs. The blowing out of the discs was not a serious inconvenience, as they could be replaced in a few minutes. By installing a blow-out head of this type on the discharge line ahead of the tee to the standpipe in the derrick and inserting a gate valve in the line just upstream from the blow-out head, the discs could be replaced without shutting down the pump. This arrangement was found to be convenient and safe.

Hose trouble was eliminated by using a high-pressure Isco rotary hose manufactured by the Boston Woven Hose and Rubber Company to withstand a pressure of 5000 lb. per sq. inch.

During the 1408 hours required to drill the 630 feet of 7¾-inch hole, 423.75 barrels of local crude oil at 70 cents per barrel was used for engine fuel. For the complete rig this represents a fuel consumption of just slightly greater than seven barrels per 24 hours. It should be stated that the experience of the drilling crew was one factor that contributed to this low fuel consumption.

Observations were made on the pulling time. It was found that the average pulling time per stand (thrible) of drill pipe was one minute and seven seconds.

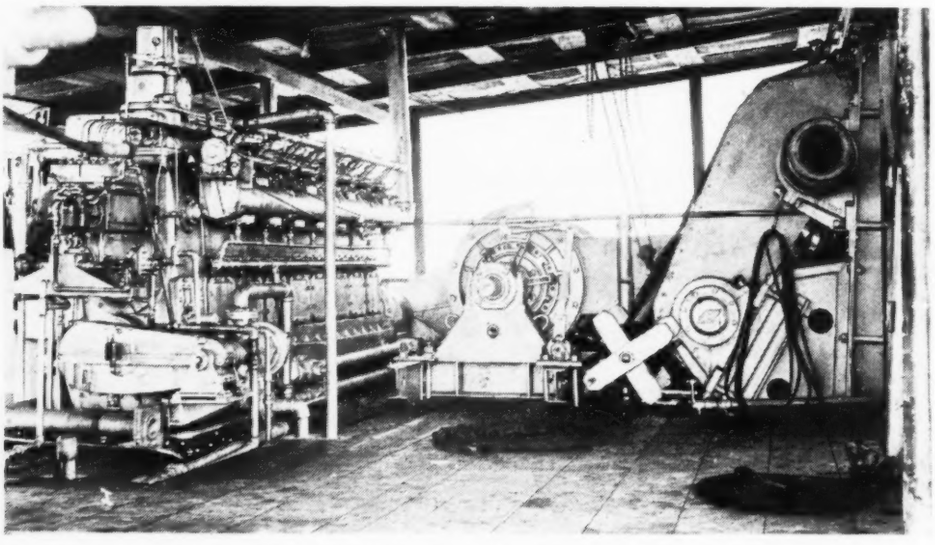
Seth Herndon of the Herndon Drilling Company, the drilling contractor on this well, deserves credit for the part he has played in pioneering the Diesel-powered rotary in the Mid-Continent fields. This rig was first used by the Herndon Drilling Company[1] on a well in Ness County, Kan. It is believed to be the first Diesel engine mechanical driven rotary rig in the Mid-Continent or the Gulf Coast to drive a conventional 3-speed drawworks merely by removing the 1240 rotary chain from the steam engine and placing it on the sprocket of the Diesel motor driven reverse clutch.

At no time has anything other than timbers been used for foundations under the engines, pumps or clutch. Nor has it ever been necessary to use any foundation bolts of any sort in anything except the reverse clutch. This attests to the inherent balance of the engines and the equipment as a whole.

The Herndon Drilling Company uses a 7½-ton White truck to handle its equipment in the field. With it one engine can be picked up off the ground and loaded on the truck as a complete unit in 10 minutes.

D. S. Deem of the Fulton Iron Works Company, manufacturers of the Fulton Diesel engine, has coöperated with the Herndon Drilling Company in adapting the Diesel engine to deep rotary drilling, and has played a prominent part in this development through being closely identified with it since its inception.

[1] "Diesel Rotary Rig Drilling" by D. S. Deem. *The Petroleum Engineer*, July, 1931, p. 78.



The 450-hp. clutch between the Diesel engine and the drawworks. Note in the center of the picture the telescoping rod for the driller's control to the engine and the clutch

STRANGE.... *but* TRUE

HAPPENINGS IN THE PETROLEUM INDUSTRY

A lease man needed an aerial for his radio. As a well was electrically shot he took a hitch on the wires and raced across the field on horseback, getting enough for six aerials. *By B. H. Leonard.*

A well equipped with 5-inch casing dropped 1000 feet of rods. Three prong grabs were run and pulled in two. Later all rods were recovered but the grabs were never found.

In hydrogenation plants machining of pipe ends is so accurate that when flange bolts are only hand-tightened the joints will withstand the system pressure of 3600 pounds.

The Turkish Government plans to utilize its excess fig crop to make alcohol and by mixing with gasoline to produce a motor fuel.

Pure Oil Company Installs Vapor Recovery Plant

By F. R. STALEY

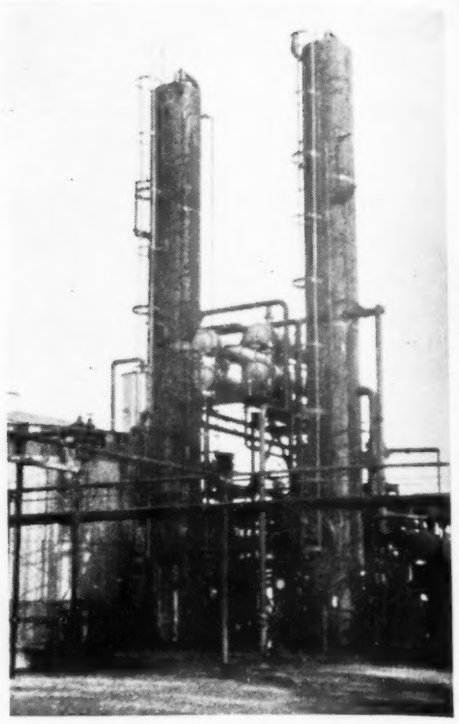
A VAPOR recovery unit and an electric power plant have been installed recently in the Pure Oil Company's refinery at Muskogee, Okla. Construction work on the power plant is nearing completion, and operations should begin before the first of the year. The recovery plant, having a daily capacity of 6,000,000 cubic feet of gas, was designed and built by Alco Products, Inc. It was put into operation last month.

The Pure Oil Company operates eight modern refineries, two of which are located in Oklahoma. The Muskogee plant is a complete plant, having a daily crude capacity of 8,000 barrels, equipped with three Gyro vapor phase cracking units, two Cross cracking units, a modern lubricating oil plant, and a grease plant. Ethyl gasoline is one of the products manufactured at this plant. Most of the motor fuel made at this refinery is delivered to the Great Lakes Pipe Line for transportation to various marketing points.

The new vapor recovery plant processes the gases produced in the cracking units and the crude distillation operation recovering a high-quality anti-knock gasoline. These gases are sweet, and require no chemical treatment. The new gasoline produced at the plant is stabilized to the desired vapor pressure and blended into motor fuel.

The new plant is built very compact, and is automatically controlled. The essential equipment comprising it consists of a Bessmer single stage compressor, a bubble tray absorption tower, a high-pressure still, a low-pressure still, pumps, heat exchangers, and condensers. The towers and heat exchangers were manufactured by Alco.

Absorber in the Pure Oil Company Plant at Muskogee, Oklahoma



High and Low Pressure Stills

The gas is compressed to 35 pounds per square inch, cooled, and admitted to the bottom of the absorber through an 8-inch line. The absorption tower is five feet in diameter and 58 feet high. The stripped gas from the absorber is used for fuel in the boilers and cracking furnaces. The rich oil from the tower flows to a surge tank, where it is picked up by a pump and discharged through heat exchangers to the high-pressure still. It exchanges heat with the lean oil from the high-pressure still. The oil from the bottom of the high-pressure still flows under pressure to the middle of the low-pressure still tower through a 4-inch line. The low-pressure still is equipped with a steam heater and a stripping section in the tower. Each of the still towers is four feet in diameter and 48 feet high. The operating pressures are 75 and 15 pounds per square inch, respectively.

The hot lean oil from the bottom of the low-pressure still is picked up by a pump having a water-cooled liquid end and discharged through a heat exchanger against the rich oil, then through a water cooler back to the top of the absorber.

The overhead from each of the stills passes through the vapor condensers, the sub-coolers, and into the separators. These tanks are vented to the gas inlet gas line to the absorber. Each of the reflux pumps takes suction on these tanks to reflux part of the streams over the high and the low-pressure still towers. The gasoline from the two separator tanks flows to a raw gasoline receiver, from which it is transferred to the stabilizer.

The absorption oil used in the plant is made at the refinery. It is about 38 A.P.I. gravity. The gasoline is stabilized to the desired vapor pressure or recovery in one of two columns, each being 30 inches in diameter and 40 feet high.

For plant control purposes distillation tests are run in the laboratory every two hours on the streams and the lean absorption oil. The tanks are tested twice daily, and fractional analyses are made each week. The average gasoline content

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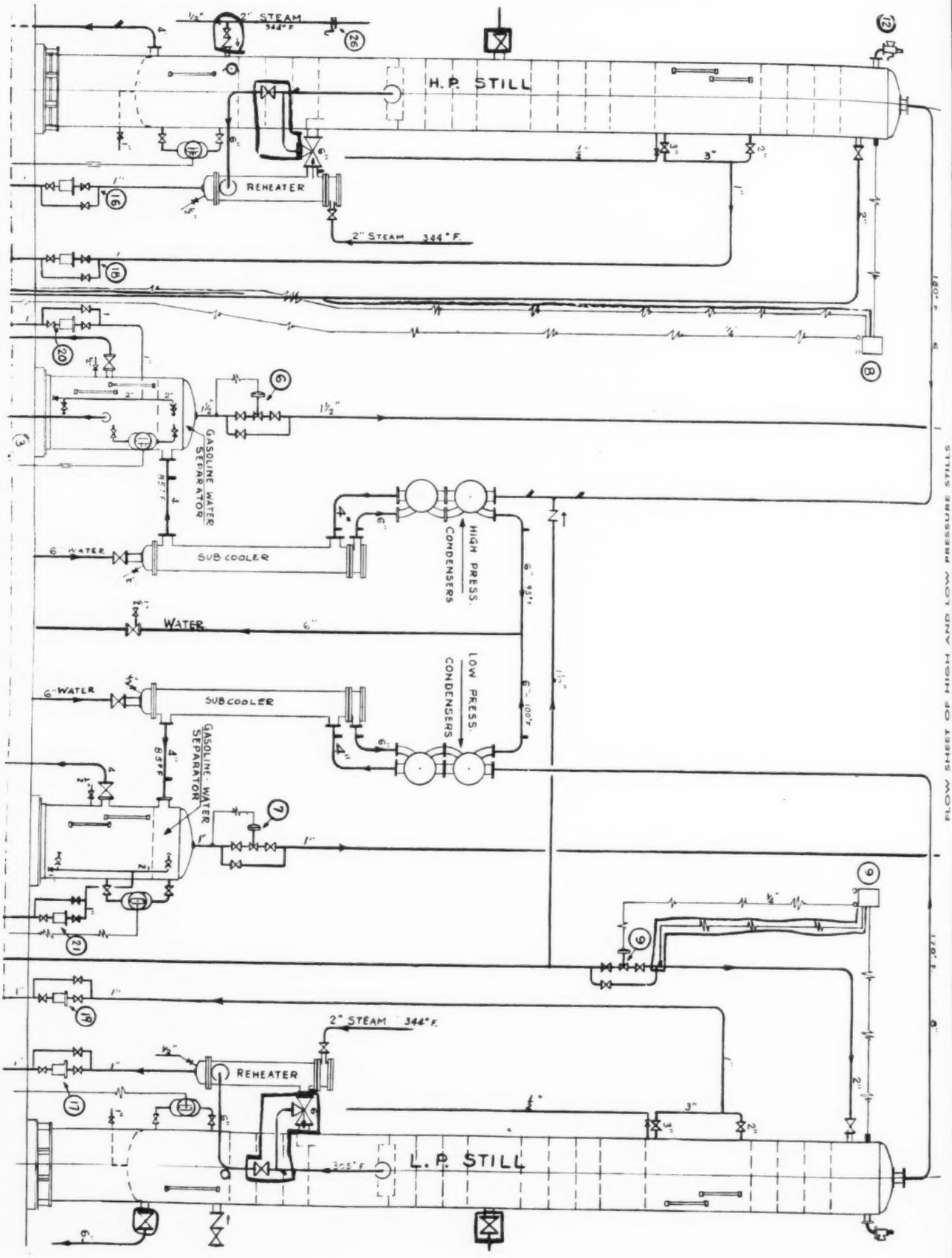


FLOW SHEET OF HIGH AND LOW PRESSURE STILLS

of the raw gas is five gallons per 1000 cubic feet. Gasoline recovered from the Gyro gas is very high in anti-knock quality, testing about 101 octane number.

All of the heat transfer equipment installed in the plant is Alco built. The units are of the tube and shell type, embodying many exclusive construction features. The tubes are accessible at both ends for inspection and cleaning without disconnecting any of the piping, by merely removing the covers. Tube bundles are removable for cleaning the exterior surfaces. The tubes are free to expand and contract independently of the shell, due to the internal floating head design. Vertical final condensers are installed for the streams from the two stills. Due to the single pass counter-flow principle and also to the fact that condensed vapors follow the tubes to the bottom of the shell, they are very effective in cooling the condensate. They occupy a minimum ground space and the tube bundles can be readily withdrawn.

The control instruments are mounted on a panel in a small brick building. Neilan pressure recording controllers are installed on the separators and the obsorber. A Metric rate volume control maintains the desired oil-gas ratio to the absorber. Foxboro pressure recording instruments are installed on both steam and gas lines. The stills and separators are equipped with Fisher liquid level controls. Consequently the operation of the plant is practically automatic.

Pumps

Six Worthington Hivol pumps are installed in the plant to handle all of the oil and gasoline. These pumps are equipped with Hills-McCanna lubricators. The pumps are installed out in the open, the steam ends being insulated and covered with a sheet metal housing to protect them from weather. Liquid end of the lean oil pump is provided with a water cooling jacket. The lean oil pump is 16 in. by 10 in. by 18 in., of simplex direct-acting type with capacity of 200 g.p.m. and a discharge pressure of 130 lb. per sq. in. The rich oil pump and spare is 16 in. by 10 in. by 18 in. of simplex direct-acting type with capacity of 225 g.p.m. and a discharge pressure of 167 lb. per sq. in. The low-pressure reflux pump and spare is 8 in. by 5 in. by 12 in. of simplex direct-acting type with capacity of 45 g.p.m. and a discharge pressure of 135 lb. per sq. in. The high-pressure reflux pump is 8 in. by 5 in. by 12 in., of simplex direct-acting type with capacity of 35 g.p.m., and a discharge pressure of 125 lb. per sq. in.

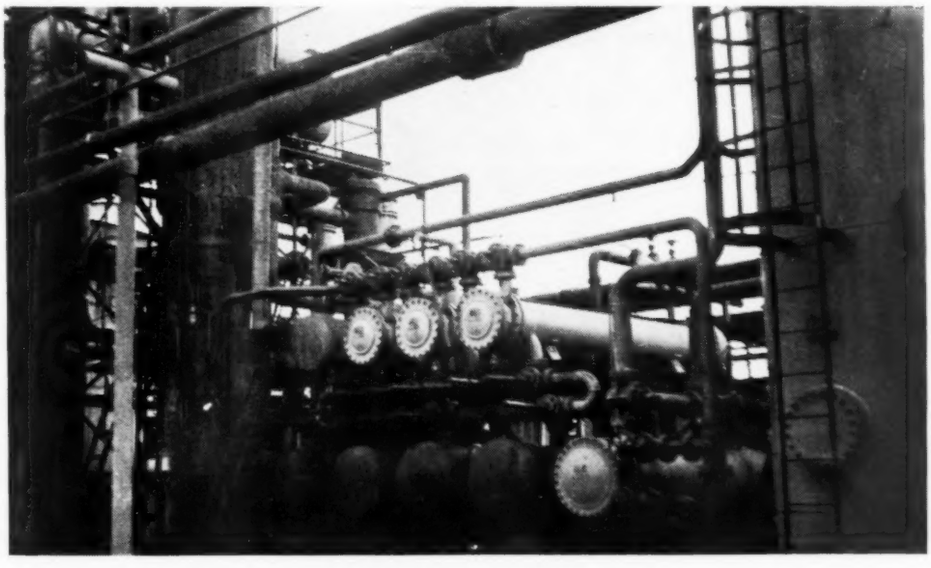
All of these pumps are especially designed to give high volumetric efficiencies for highly volatile liquids. In any pump to be used for handling volatile liquids, provision must be made for completely filling the pump chamber on the suction stroke with the least possible reduction of pressure on the liquid. Otherwise, the liquid will vaporize and the pump will be either greatly reduced in capacity, or become vapor bound. The most practical way of solving this problem is to maintain the suction supply level at a sufficient height above the discharge valves to provide a static head great enough to offset pressure losses, overcome frictional losses in the pump and supply lines, and balance the weight of the suction valve and the pressure of the suction valve spring. The direct line flow construction of these pumps, with light-weight suction valves below the cylinder and discharge valves above provides for operation with extremely high efficiencies on butane, propane, casing-head gasoline and other liquids of a highly volatile nature.

The Gyro Process

The Gyro cracking process is used in all Pure Oil refineries. An agreement has recently been made between the Alco Products, Inc., and the Gyro Process Corporation, a subsidiary of the Pure Oil Company, whereby Alco has acquired exclusive licensing, sales, engineering and manufacturing rights for the Gyro Vaporphase Cracking Process for manufacturing anti-knock gasoline. Gyro cracking process is the result of research begun during the World War, the purpose of which was to produce fuels for high-compression engines.

In this process cracking takes place without the use of extremely high pressures. The product, when blended with straight-run gasoline, produces motor fuels of exceptionally high anti-knock ratings. The Gyro gases contain hydrocarbon compounds which can be used in the manufacture of a variety of synthetic chemicals. There are a number of plants in the United States manufacturing commercial chemicals and solvents from cracked gases.

The addition of these two units to the Muskogee plant makes it one of the most modern refineries in the state. The policy of the Pure Oil Company is to maintain all of its properties at the highest degree of efficiency, even during the present.



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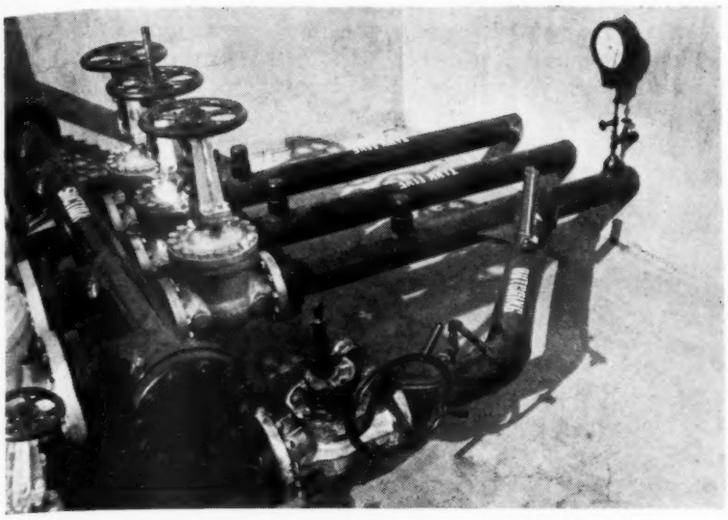


A section of the manifold at Okmulgee, Okla., Station of the Great Lakes Pipe Line Company

Tapping Is Serious Problem of Gasoline Pipe Line Operation

By J. H. DAMERON

ORDERLINESS of the premises of a pipe line station is usually an indication that the machinery is well cared for and that the operator is safety conscious. Consequently the Great Lakes Pipe Line Company, Kansas City, Mo., is constantly encouraging station engineers to improve the general appearance of station machinery and equipment. The system pays dividends in the form of low operating and maintenance costs, and makes for a more alert and efficient operating personnel.

Okmulgee station at Okmulgee, Okla., is an example of what may be found at any of their main line stations. The machinery is comparatively new, having been in operation about two years, and its appearance practically as good as the day it was installed.

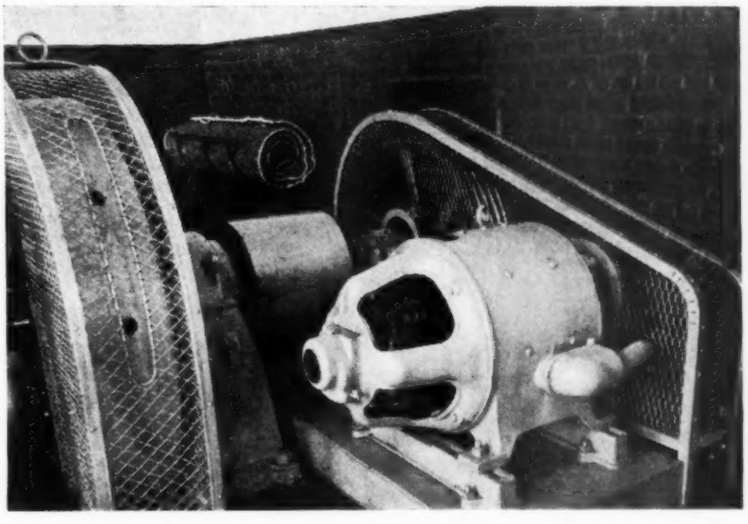
At Okmulgee the operating crew is always on the alert for oil leaks or any minor irregularity about the station. Each engine is painted with battleship gray paint. Daily the engine is gone over by the oiler and once each week the finish of the paint is brightened by use of a hot cleaning solution. The solution consists of hot water containing about a pint of Shinol (a cleaning liquid) per gallon of water. These proportions serve, providing the paint is not badly stained with oil. In the latter event a greater amount of liquid cleaner is used. The cleaning solution removes the dust and grime from the paint surface and if used in correct proportions and not applied too briskly will not damage the paint. The 175-hp. vertical Diesel engines, powering reciprocating pumps in the station, were painted about a year ago and the finish is apparently good for some time.

In order to protect the floor while repairs are being made to engines or pumps, a felt mat covered with heavy canvas is spread upon the floor. The felt in the mat is about 1 inch thick and the mat is 5 feet wide and about 12 feet long. Rope is fastened to the edges and looped at short intervals to facilitate handling the mat. When not in use the mat is rolled up and racked on a conveniently located rack attached to the fire wall on the engine room side. The mat is heavy enough to cushion the blow of falling tools that might otherwise chip the surface of the floor.

To make it possible to keep the pumps clean, light snug-fitting steel covers were designed to fit over the exposed nuts on top of the pump barrel.

All of the moving parts of machinery which are exposed are enclosed in heavy wire or light metal safety guards. The engine coupling is enclosed in a light steel case attached to the bearing pedestals. The pinion shaft is enclosed from the fire wall to the pump in a long circular guard attached to the fire wall and the pump frame.

To replace the first gate valve boxes, which were made of heavy timber and are difficult to maintain, the company is using gate valve boxes made of 12-gauge corrugated gal-



V-belt drive from the pinion shaft to the generator, showing a new type cover for the coupling

vanized iron. The bottom of the iron boxes are attached to a base about three inches wide. Two sides of the box are cut at the bottom to fit over the diameter of pipe where valves are installed. The top has hinged covers opening outward, which may be locked to prevent tampering. The boxes are easily installed, stay in position once they are set, and their maintenance is negligible.

Thefts of gasoline from the line by line tappers is a problem that has caused no little trouble to Mid-Continent gasoline transporters. One company, handling only finished grades of gasoline through its system, has experienced a great deal of trouble. Another transporter, pumping unblended gasoline through its line, has experienced less trouble, due, perhaps, to the fact that it is generally known that unblended refined products, including liquid butane, are "slugged" through the line.

The line tappers invariably have left evidence of their work at the point where the line was tapped, making it easy for the line walker, patrolling that section of the system, to find the point of connection.

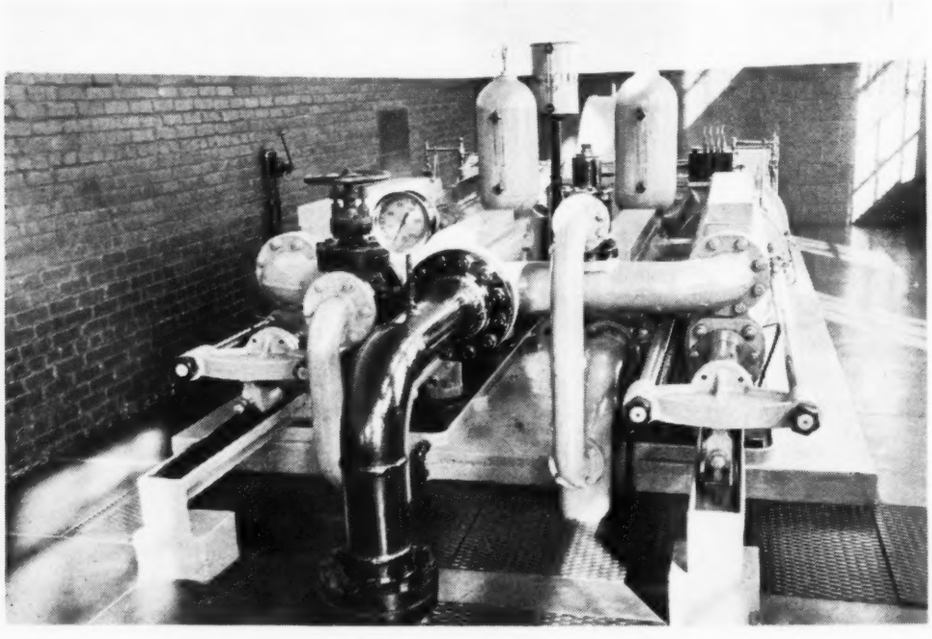
The Great Lakes Company employs a dual method to assist in checking operations of line tappers. Line walkers patrol the main and lateral lines daily, searching for leaks and any disturbed condition of the right-of-way that might indicate efforts on the part of anyone to tap the line. The hourly gauges, used to check deliveries, will indicate a leak which is immediately checked. As a means of timing and more readily discovering leaks the company uses recording gauges located on the discharge lines of each station. Should the recording gauge register a sudden drop in pressure that perhaps would not be observed on the indicating gauges this fact is reported to headquarters immediately.

Line tappers have learned on a few occasions the time when certain stations would be shut down. Taking advantage of this condition, when pressure in the line would ordinarily be low, the line tapper starts drilling into the pipe line for a tap connection with less chance of his operations being detected at the time by anyone except the line walkers.

To prevent this happening the Great Lakes Company installed plug valves on both the discharge and receiving lines of each station manifold. Whenever it is desired to shut down any section of its system, pressure is built up in that section. With the pressure up to about 800 pounds the spur-geared plug cocks are closed and effect a tight shut-off. Within about two hours the pressure in the line will have dropped anywhere from 25 to 75 lbs. as the line pressure is equalized. The pressure should then remain constant. Just inside the manifold pit and on the discharge line is a recording pressure gauge. This gauge is observed hourly and usually at more frequent periods. Should that gauge record a sharp drop in pressure, a report is made immediately and steps taken to determine the cause. By having the line loaded at a high pressure when it is not in service the station crew is enabled to tell the exact time when a sudden leak develops and by the action of the gauge they may reasonably speculate whether the line is being tapped or whether it is a leak due to failure of material or equipment. At the same time it makes the line tapper's work more hazardous, because he is confronted with the task of working on a line under high pressure.

Whenever it is suspected that line tappers are at work key men in the division are notified. If the occasion justifies men are sent out from each station to walk to a common meeting point on a section of the line. At other times the report of the line walker is awaited. After gaining knowledge of line tapping special agents then make plans to track down those responsible for tapping the line.

As a means of checking the exact amount of gasoline used at each station, either for sampling or for fuel of the gasoline engine powered auxiliary equipment, the gasoline is passed through a recording meter. The meter line is located on the incoming line to the station manifold. The piping consists of ½-in. pipe and the meter is of a small standard type similar to water meters. A ¼-inch connection is tied into the ½-inch line and is used to draw samples for gravity tests at the stations. The ½-inch line extends to the gasoline fuel tanks at the station. With the use of this meter, which registers the volume passing through it in gallons, all of the gasoline drawn from the line by the station operating crew is accounted for. All other connections to the manifold are plugged.



Pump-room showing covers used on top of pump barrels

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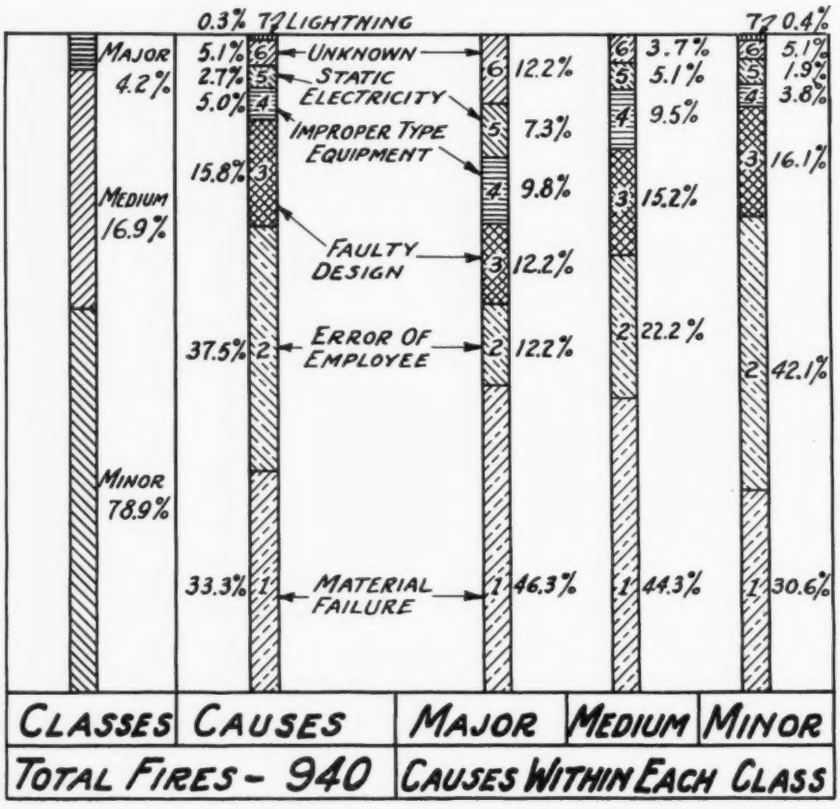
The Accident Situation in the Petroleum Industry

By H. N. BLAKESLEE☆

WHAT is the accident situation in the petroleum industry? This question can best be answered by comparing the situation now with the situation five years ago. In 1927 the accident frequency rate in the petroleum industry was 18 per cent worse than the average for all industry. In 1930 the accident frequency rate of the petroleum industry had improved to a point slightly better than the average for all industry. The average accident frequency rate for all industry had improved 30 per cent in those four years and the rate had improved 42 per cent in the petroleum industry.

Accidents have declined in the past five years, and what has brought about this decline? More companies are doing accident prevention work, and companies that were active in accident prevention work in 1927 are now doing better work. Safety originated as sort of a religion in the interest of the prevention of suffering. It was carried on largely by propaganda, but today safety has changed to the science of accident prevention, which is the science of correct operation.



Carelessness is no longer accepted as the cause of an accident. Carelessness is considered as only an excuse or an alibi. It is agreed that every accident is the result of a mistake or wrong doing of someone, that accidents are all caused by either ignorance, indifference or insubordination, and that these causes can be eliminated by providing the worker with complete information on the right and safe way of doing the job. The worker who is fully informed on the correct and safe way of doing the work is aware of the hazard that may exist by using other methods. The worker who is fully informed is so decidedly interested in his work that he will not be guilty of indifference or insubordination.

Do men know more about their work in the oil industry now than they did a few years ago? The answer is, "Yes, they do." Well managed companies are conducting training in their organizations which was unheard of a few years ago. Superintendents and foremen are called together once or twice a year to discuss the various problems of the company and accident prevention always comes in for consideration. Committee meetings and employe meetings are being held to discuss safe and correct operations. Every employe is given a chance to offer constructive suggestions. In fact, in many companies workers, from the highest executive to the roustabout, now consider that they can prove their knowledge of the job and their ability to handle the job as it should be handled by doing the work without accidents.

The Casper, Wyoming, Refinery, Standard Oil Company (Indiana), employing from 700 to 1,000 men, has worked since October, 1930, without a lost time injury and is still going. The Kansas City sales division of the same company, with over 900 employes, worked for an entire year without a lost time injury, not a single fire loss, and only one small property damage case.

The Tonkawa Production Division of the Shell Petroleum Corporation has accomplished the equivalent of 565 men working an entire year in general field operations without a disabling injury. The Shell Petroleum Corporation has just released information to the effect that the cost of accidents per employe on the payroll has declined over 70 per cent since 1927. The Beaumont refinery of the Magnolia Petroleum Company has reduced the cost of accidents 76 per cent per payroll employe since 1929. These reductions are not made by curtailing medical care but by actually preventing the accidents and, when one does occur, providing the best medical care possible. Accident prevention is a good business proposition for any company, but it is a better business proposition for the worker, as he is the one who suffers the pain and a proportionately great economic loss, as compensation never meets the current bills as well as the regular pay check.

It can be readily seen that the industry realizes the benefit to be derived from accident prevention and is extending an effort in a business-like way to prevent accidents. Progress in accident prevention has been made in the past, but even greater progress should be made in succeeding years. This, however, depends upon the thought and consideration given accident prevention by each oil company and each oil worker.

☆Department of Accident Prevention, American Petroleum Institute.

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THE S. M JONES Co
1932

SUCKER ROD LOAD CH

PHYSICAL AND CHEMICAL PROPERTIES OF JONES AND OTHER S

TYPE STEEL	SIZE	AREA □	MINIMUM YIELD IN POUNDS	MINIMUM ULTIMATE IN POUNDS.	%EL 2" MIN.	%R.A. MIN.	ENDURANCE LIMIT LBS.		
							AIR	SALT WATER	H_2S WATER
JONES HIGH MANGANESE STEEL	3/8	.307	21500	35200	25	50	17480	9050	3950
	3/4	.442	30900	50800	25	50	25180	13000	5700
	7/8	.601	42100	69100	25	50	34270	17700	7800
A LOW MANGANESE STEEL	5/8	.307	19900	30700	25	55	15900	6450	4920
	3/4	.442	28000	44000	25	55	22900	9260	7050
	7/8	.601	38000	60000	25	55	31900	12630	9620
A CARBON STEEL	5/8	.307	15300	26400	20	45	13200	5530	3070
	3/4	.442	22100	38000	20	45	19000	7950	4420
	7/8	.601	30100	51700	20	45	25900	10820	6010

NOTE:- THE SAFE WORKING LOAD FOR ANY SIZE ROD IS THE ENDURANCE LIMIT
IN WHICH IT OPERATES. IF THE MAXIMUM IMPULSE LOAD EXCEEDS THE E
FAILURES WILL RESULT. REDUCE THE LOAD BY USING COMBINATION STRI
RATIO BY ALTERING SPEED OR SPEED AND STROKE.

SIZE OF SUCKER ROD.	VOLUME AND WEIGHTS OF SUCKER RODS PER 100 FEET		VOLUMES AND WEIGHTS OF PLUNGER SUPPORTED FLUID AND DEAD WEI PER 100 FEET IN CUBIC INCHES AND POUNDS. FLUID WEIGHT SAME AS																			
			PLUNGER DIA 15/16			1"			1 1/16"			1 1/4			1 1/2			1 3/4			2		
	VOL.	WT.	VOL.	WT.	D.W.	V	W	D.W	V	W	D.W	V	W	D.W.	V	W	D.W.	V	W	D.W.	V	W	D.W
5/8	407	115	421	15	130	535	19	134	661	24	139	1065	39	154	1713	62	177	2485	90	205	3363	122	237
3/4	577	164	251	9	173	365	13	177	491	17	181	895	32	196	1543	55	219	2315	83	247	3193	115	279
7/8	775	220	53	2	221	167	6	226	293	10	230	697	25	245	1345	48	268	2117	76	296	2985	108	328

SPECIFIC GRAVITY CORRESPONDING TO DEGREES A.

DEGREES A.P.I.	S.G. 60°	A.P.I.	S.G.	A.P.I.	S.G.	A.P.I.	S.G.	A.P.I.
10	1.000	26	.898	42	.816	58	.747	74
11	.993	27	.893	43	.811	59	.743	75
12	.986	28	.887	44	.806	60	.739	76
13	.979	29	.882	45	.802	61	.735	77
14	.973	30	.876	46	.797	62	.731	78
15	.966	31	.871	47	.793	63	.728	79
16	.959	32	.865	48	.788	64	.724	80
17	.953	33	.860	49	.784	65	.720	81
18	.946	34	.855	50	.780	66	.717	82
19	.940	35	.850	51	.775	67	.713	83
20	.934	36	.845	52	.771	68	.709	84
21	.928	37	.840	53	.767	69	.706	85
22	.923	38	.835	54	.763	70	.702	86
23	.916	39	.830	55	.759	71	.699	87
24	.910	40	.825	56	.755	72	.695	88
25	.904	41	.820	57	.751	73	.692	89

CHART THE S.M. JONES CO TOLED

SUCKER RODS

	CHEMISTRY				
R	C	MN.	PHOS.	SU.	SI.
	30/40	1.60/1.90	04 MAX	04 MAX	15/30
	30/40	1.10/1.40	04 MAX	04 MAX	15/30
	40/50	50/80	04 MAX	04 MAX	

T OF THE ROD IN THE MEDIA
ENDURANCE LIMIT, EXCESSIVE
RINGS, OR REDUCE IMPULSE

EIGHTS OF FLUID AND RODS
AS WATER 1.00 SPECIFIC GRAVITY

	2¼			2¾			3¾		
D.W	V	W	D.W	V	W	D.W	V	W	D.W
237	4364	158	273	6721	243	358	12891	465	580
279	4194	151	315	6551	237	401	1267	458	622
228	3996	144	364	6353	229	449	12473	451	671

A.P.I.

	S.G	A.P.I.	S.G.
	.689	90	.639
	.685	91	.636
	.682	92	.683
	.679	93	.630
	.675	94	.628
	.672	95	.625
	.669	96	.622
	.666	97	.619
	.663	98	.617
	.660	99	.614
	.657	100	.611
	.654		
	.651		
	.648		
	.645		
	.642		

GRAPH FOR DETERMINATING AMOUNT OF ⅞" OR ¾" RODS IN COM

DEPTH OF PUMP IN FEET.

8000 7000 6000 5000 4000 3800 3600 3400 3200 3000 2800 2600 2400 2200 2000 1800 1500 1400 1200 1000

AMOUNT OF ⅞" OR ¾" RODS IN FEET.

FLUID .875 SP. GRAVITY.

6000 5000 4500 4000 3500 3000 2500 2000 1500 1000 900 800 700 600 500 400 300 200

8000 7000 | 108000 90000 80000 70000 60000 | 1260 1200 1100 1000 | 700 600

ROD LOAD CHART THE S.M. JONES

PERTIES OF JONES AND OTHER SUCKER RODS

ENDURANCE LIMIT LBS.			CHEMISTRY				
AIR	SALT WATER	H_2S WATER	C	MN.	PHOS.	SU.	SI.
7480	9050	3950	30/40	1.60/1.90	04 MAX	04 MAX	15/30
5180	13000	5700					
4270	17700	7800					
15900	6450	4920	30/40	1.10/1.40	04 MAX	04 MAX	15/30
22900	9260	7050					
31900	12630	9620					
13200	5530	3070	40/50	50/80	04 MAX	04 MAX	
19000	7950	4420					
25900	10820	6010					

ZE ROD IS THE ENDURANCE LIMIT OF THE ROD IN THE MEDIA
MUM IMPULSE LOAD EXCEEDS THE ENDURANCE LIMIT, EXCESSIVE
E LOAD BY USING COMBINATION STRINGS, OR REDUCE IMPULSE
ED AND STROKE.

ER SUPPORTED FLUID AND DEAD WEIGHTS OF FLUID AND RODS
AND POUNDS. FLUID WEIGHT SAME AS WATER 1.00 SPECIFIC GRAVITY

1¼		1½			1¾			2			2¼			2¾			3¾		
W	D.W.	V	W	D.W.	V	W	D.W.	V	W	D.W	V	W	D.W.	V	W	D.W.	V	W	D.W
39	154	1713	62	177	2985	90	205	3363	122	237	4364	158	273	6721	243	358	12891	465	580
32	196	1543	55	219	2315	83	247	3193	115	279	4194	151	315	6551	237	401	1267	458	622
25	245	1345	48	268	2117	76	296	2995	108	328	3996	144	364	6353	229	449	12473	451	671

CORRESPONDING TO DEGREES A.P.I.

S.G.	A.P.I.	S.G	A.P.I.	S.G	A.P.I.	S.G
.816	58	.747	74	.689	90	.639
.811	59	.743	75	.685	91	.636
.806	60	.739	76	.682	92	.683
.802	61	.735	77	.679	93	.630
.797	62	.731	78	.675	94	.628
.793	63	.728	79	.672	95	.625
.788	64	.724	80	.669	96	.622
.784	65	.720	81	.666	97	.619
.780	66	.717	82	.663	98	.617
.775	67	.713	83	.660	99	.614
.771	68	.709	84	.657	100	.611
.767	69	.706	85	.654		
.763	70	.702	86	.651		
.759	71	.699	87	.648		
.755	72	.695	88	.645		
.751	73	.692	89	.642		

GRAPH FOR DETERMINATI

DEPTH OF PUMP IN FEET.

8000
7000
6000
5000
4000
3800
3600
3400
3200
3000
2800
2600
2400
2200
2000
1800
1600
1400
1200
1000

1.80
1.70
8000
7000
108000
90000
80000
70000

		19		940		35		.850		51		.775		67									

ES CO TOLEDO OHIO

ATING AMOUNT OF $\frac{7}{8}$" OR $\frac{3}{4}$" RODS IN COMBINATION STRINGS OF $\frac{7}{8}$" & $\frac{3}{4}$" AND $\frac{3}{4}$" & $\frac{5}{8}$"

AMOUNT OF $\frac{7}{8}$" OR $\frac{3}{4}$" RODS IN FEET.
FLUID .875 SP. GRAVITY.

6000
5000
4500
4000
3500
3000
2500
2000
1500
1000
900
800
700
600
500
400
300
200

PUMP PLUNGER DIAMETER IN INCHES

$3\frac{3}{4}$"
$2\frac{3}{4}$"
$2\frac{2}{16}$"
$2\frac{1}{4}$"
$2\frac{3}{4}$"
2"
$2\frac{2}{16}$"
$1\frac{3}{4}$"
$2\frac{1}{4}$"
$1\frac{1}{2}$"
2"
$1\frac{1}{4}$"
$1\frac{3}{4}$"
$1\frac{1}{16}$"
$1\frac{1}{8}$"
$1\frac{1}{2}$"
$1\frac{1}{4}$"
$1\frac{1}{16}$"
1"
$\frac{15}{16}$"

USE THIS SIDE OF SCALE FOR $\frac{3}{4}$" & $\frac{5}{8}$" RODS.

NOTE:- USE THIS SIDE OF SCALE FOR COMBINATION $\frac{7}{8}$" & $\frac{3}{4}$" RODS

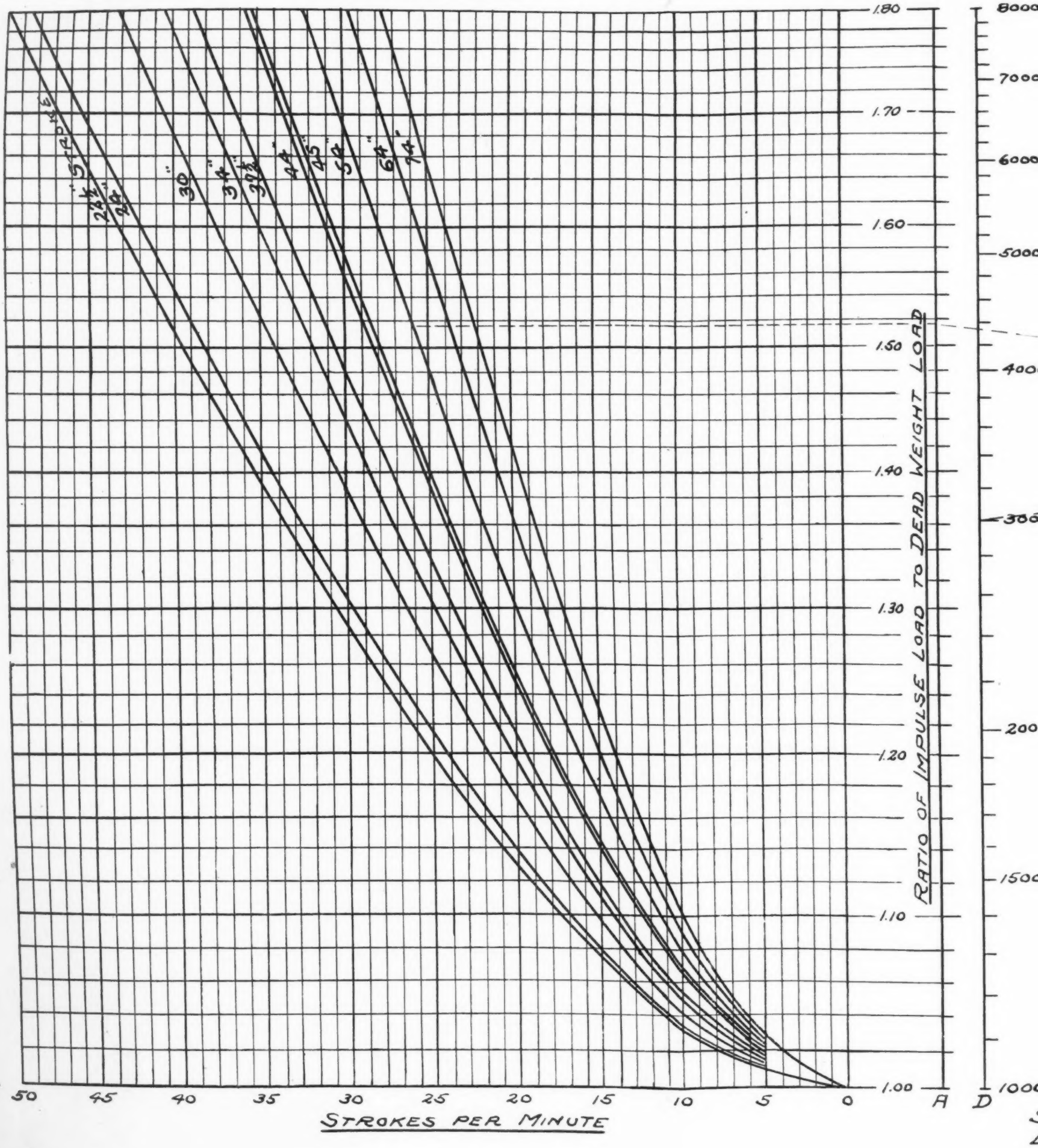
1260
1200
1100
1000

700
600

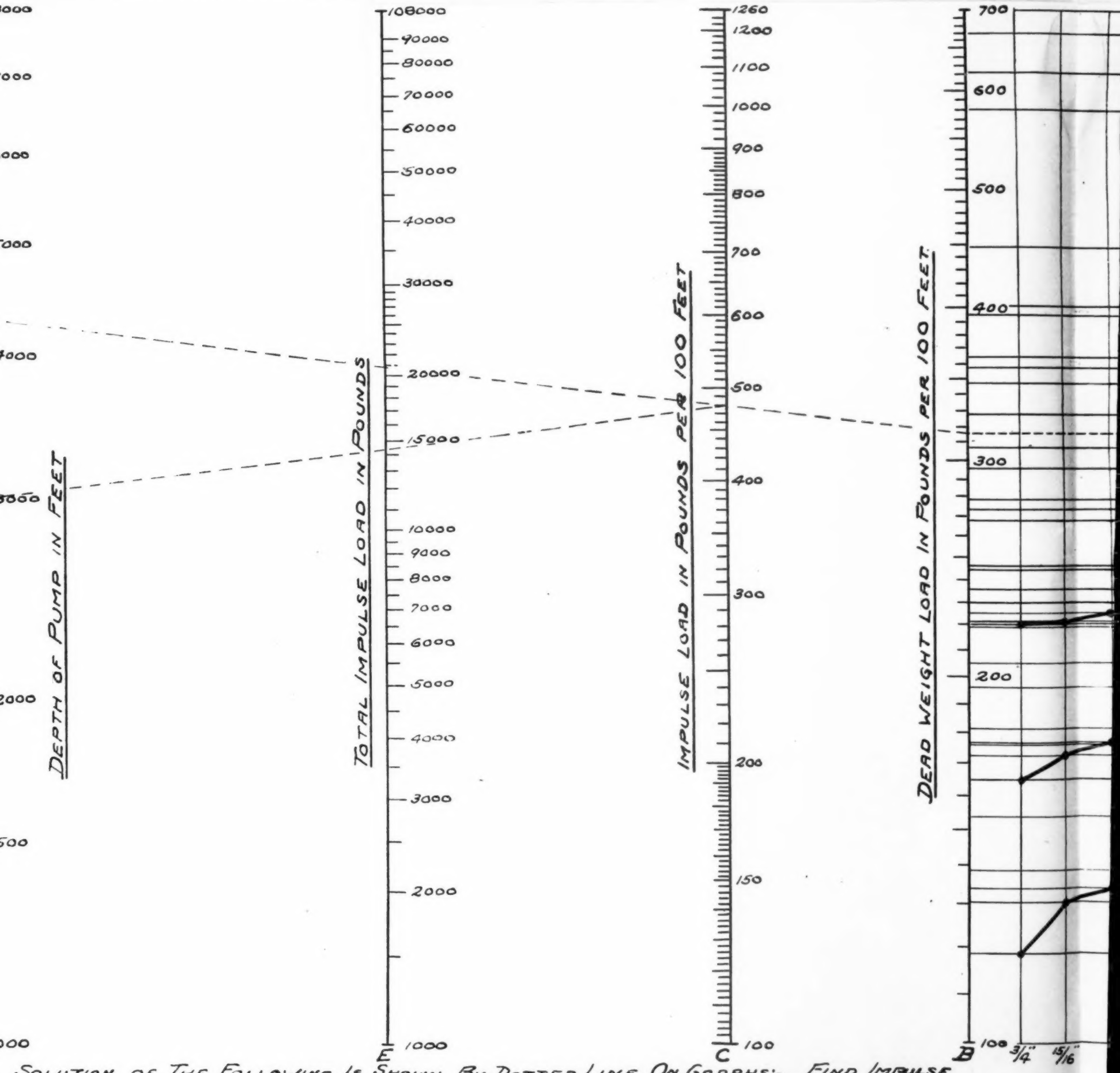
671#
622
580

650	100	.611

19	.940	35	.850	51	.775	67	[illegible]	[illegible]	[illegible]
20	.934	36	.845	52	.771	68	.709	84	.6
21	.928	37	.840	53	.767	69	.706	85	.6
22	.923	38	.835	54	.763	70	.702	86	.6
23	.916	39	.830	55	.759	71	.699	87	.6
24	.910	40	.825	56	.755	72	.695	88	.6
25	.904	41	.820	57	.751	73	.692	89	.6



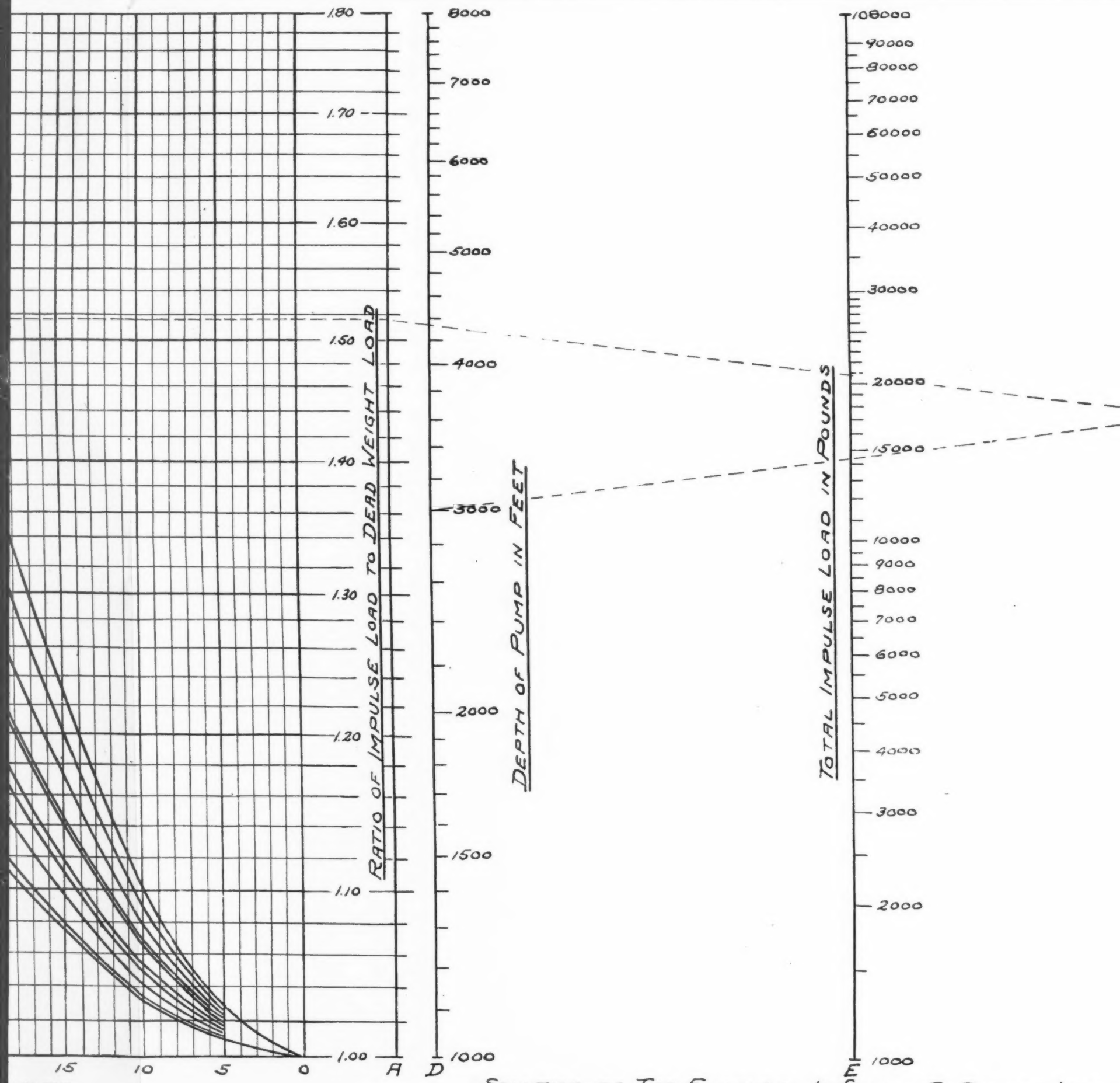
.657	100	.611
.654		
.651		
.648		
.645		
.642		



SOLUTION OF THE FOLLOWING IS SHOWN BY DOTTED LINE ON GRAPHS:- FIND IMPULSE LOAD ON TOP ROD OF A WELL 3000 FT. DEEP, 2¼" PLUNGER, ¾" RODS, RUNNING 26 STROKES PER MINUTE, 54" STROKE. ANSWER IS SHOWN ON SCALE "E".

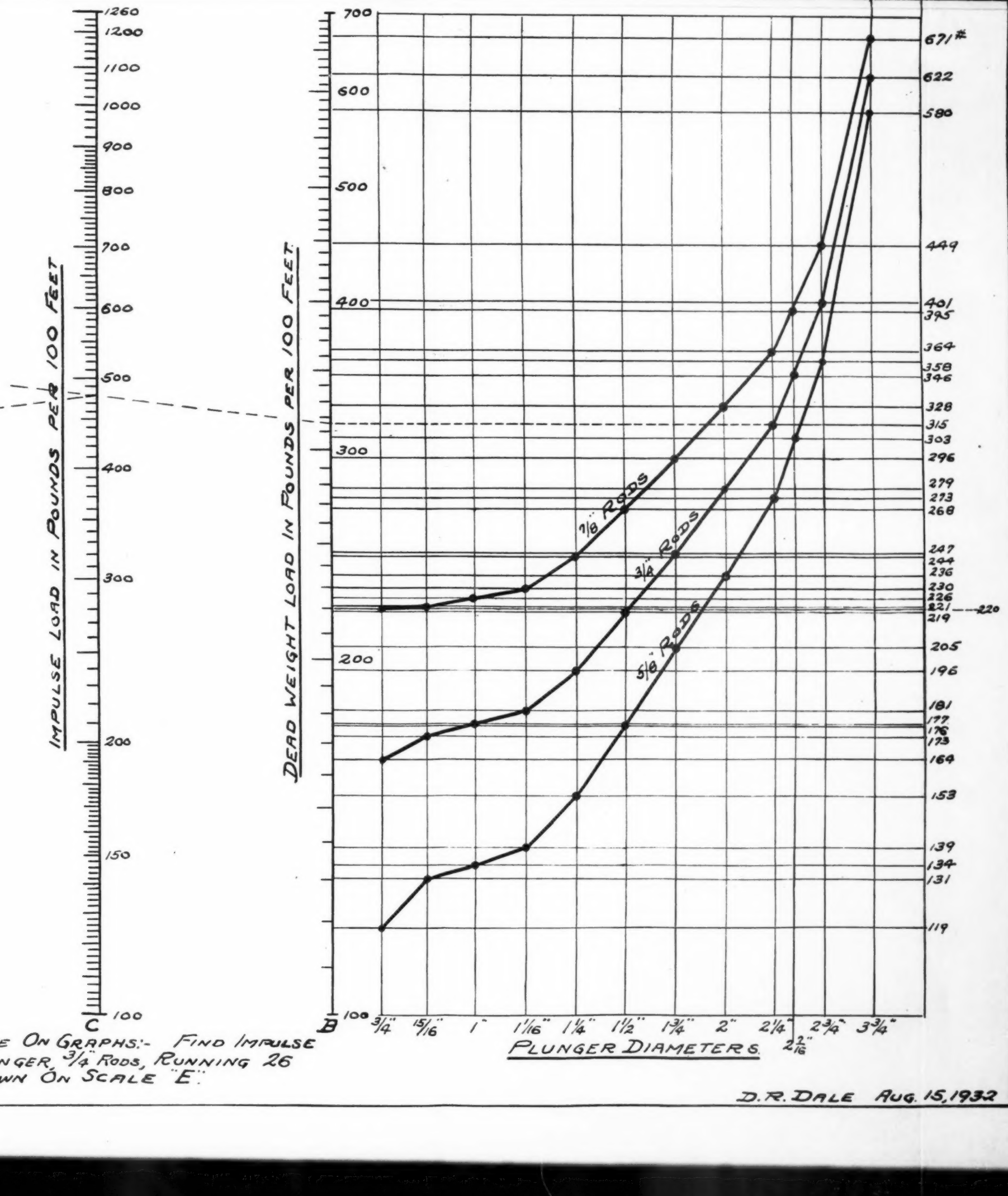
.771	68	.709	84	.657	100	.611
.767	69	.706	85	.654		
.763	70	.702	86	.651		
.759	71	.699	87	.648		
.755	72	.695	88	.645		
.751	73	.692	84	.642		

1200
1000



NUTE

SOLUTION OF THE FOLLOWING IS SHOWN BY DOTTED LINE
LOAD ON TOP ROD OF A WELL 3000 FT. DEEP, 2¼" PLUNG
STROKES PER MINUTE, 54" STROKE. ANSWER IS SHOWN



E ON GRAPHS:- FIND IMPULSE
NGER, 3/4" RODS, RUNNING 26
WN ON SCALE "E".

D. R. DALE AUG. 15, 1932

CHART FOR DETERMINING SUCKER ROD LOADS AND PROPORTIONS OF RODS IN MIXED OR TAPERED STRINGS

Additional charts and supplemental information will be furnished on request

THE S. M. JONES COMPANY

TOLEDO, OHIO

McBIRNEY BUILDING, TULSA, OKLAHOMA

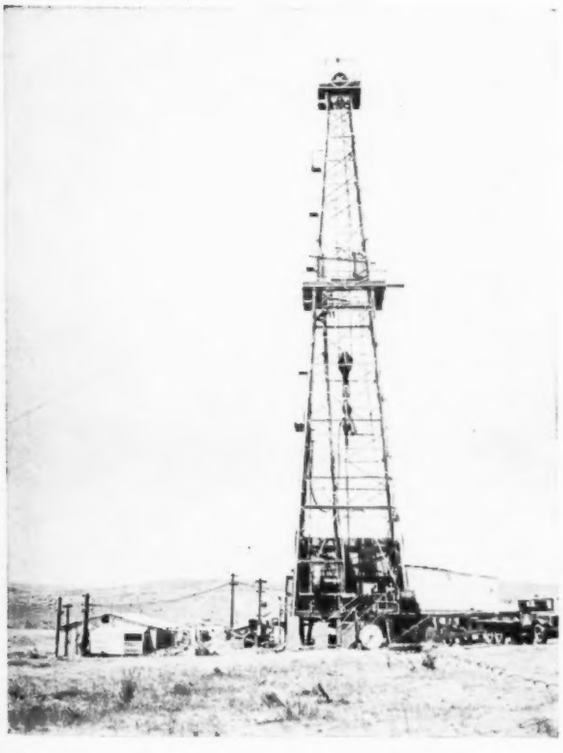
UNIV. OF MICH.

Kettleman Hills Proves Out Equipment

Here is a string of 6-inch flush joint drill pipe used to drill to a depth of 7574 feet

WHILE record depths are not being made in the Kettleman Hills field, California, many interesting deep-drilling data are constantly being procured. The formations, the great pressures that have to be anticipated if production is obtained and many other factors have here necessitated such careful drilling that much valuable information has been obtained to advance the science of deep well completion. Here, too, has been shown to what great extent equipment can be applied beyond the limits to which it has previously been put; and every example of the successful use of equipment under such conditions is of interest to all operators. The Powell-Stockton well in the southwest corner of Section 32-22N-19E has established several records of this nature and has called attention to the use of long strings of surface casing, deep holes of big diameter and excessively heavy strings of drill pipe.

This well, being located a considerable distance south and east of the nearest producer on the North Dome of Kettleman Hills, may or may not be classed as a wildcat or semi-wildcat. Whether or not it is ever completed as a producer does not enter into this discussion. It was, however, drilled with great care, under competent supervision and with good equipment. The well has been shut down for some time at 7574 feet after the completion of a fishing job.



A 15-inch hole was carried to below 7500 feet in this well in the Kettlemen Hills

The drilling rig used was a Hydril hydraulic table and drawworks powered by a 150-h. p. variable speed electric motor. Circulation was handled by two Wilson-Snyder 6 x 16 pumps and an Oilwell 7 x 14 pump. Pump pressure during the drilling sometimes reached as high as 1000 lb. per. sq. inch. A vibrating screen was used on the mud returns and admixtures in varying amounts were used with the mud at various times. Other equipment included a Shaffer control gate for high pressures with a packer at the top. The derrick was a 136-ft. Ideco.

The first record established was with a string of 16-inch O. D. 65-lb., surface pipe which was set at 1900 feet. This was the longest string of 16-inch casing yet to be run in a well and its joints were arc welded throughout its length.

A 15-inch hole was then drilled to 7574 feet and established a depth record for that size hole. This was drilled to 6200 feet with fish-tail bits and from that point to 7574 feet with special bits designed on the job. The hole was cored with a 15-inch core barrel for the last 1000 feet and at intervals above the 6500-ft. depth.

The drill pipe was 6-inch flush joint and was the longest string of that size ever used to drill a well. Its total weight was in excess of 100 tons and the entire string can be seen piled up outside the derrick in an accompanying illustration. No twist-offs occurred during the drilling of the well.

The drill collar was also out of the ordinary. It was about 10 inches in diameter and was solid except for the circulation passage. A 58-foot section weighing 220 lb. per foot and the entire length of 93 feet weighed over nine tons. It is felt that this gave a hanging-weight effect at the bit and was of assistance in keeping the hole straight. The straightness of the hole was also a feature of the well and it is claimed that tests taken from 5400 feet down showed no angle of inclination greater than one-quarter degree.

During the drilling of the 15-inch hole the power went off for 28 minutes and allowed the drill pipe to freeze at seven stands off bottom. This happened when the hole was down to its final depth of 7574 feet. The fishing job resulting was completed successfully and a string of 8⅝-inch casing then run.

The 8⅝-inch pipe was all flush joint and was cemented at 6650 feet. The upper half was 43-lb. per foot and the lower 36-lb. per foot, The string went into the hole without any difficulty and could easily be turned when in position.

Petroleum Specialities: Insecticides

By S. J. CAPLAN, Chemical Engineer

ESPECIALLY during the summer months there is a large demand for preparations made for the destruction of insect pests. Petroleum distillates and refined oils are the most satisfactory base materials used in manufacturing sprays and dips. They can be prepared in the grease plant or in the refinery laboratory and sold as specialty products. A number of satisfactory formulae for various preparations that have proved effective are given in this article.

In the following insecticide formulae care has been taken to avoid cause for complaints from the housewife. For example, an insecticide, no matter how efficient, would be considered useless by the housewife if it stained household furnishings. Then again, an insecticide that left an obnoxious odor could not be continuously marketed. These practical thoughts have always been kept in mind in developing the formulae.

The house fly, bedbug, cockroach and moth are the four principal insects against which the household must wage continuous battle.

The house fly is probably the most dangerous of the group. It is a carrier of the germs of intestinal diseases such as dysentery, typhoid and cholera, also of germs such as diphtheria and tuberculosis. A single female fly may deposit as many as 2000 eggs in a space of thirty-six hours.

Fly Spray

Fly sprays which enjoy the largest distribution are those made from pyrethrum flowers. The pyrethrum is cultivated principally in Dalmatia, Persia and Japan. The active principle of pyrethrum is contained in the flower. This active ingredient, which is known as pyrethrine, is present only in very small amounts. It is this pyrethrine that has the property of killing flies.

The standard method for making a fly spray consists in allowing a good grade of kerosene to percolate through a bed of coarsely ground pyrethrum flowers. The kerosene should flow evenly through the bed of the pyrethrum. One gallon of kerosene is used for each pound of flowers and the percolation should take about three days, in order to extract practically all of the available pyrethrine. After the extraction is completed, a half-ounce of perfume is added per gallon of fly spray, in order to give the spray a pleasing odor.

It is at present possible to purchase a concentrated extract of pyrethrum flowers. In order to make a fly spray from this concentrate, it is merely necessary to mix the concentrate with the amount of kerosene that is recommended by the manufacturer of the extract.

Liquid Bedbug and Roach Insecticide

The bedbug is a true "bloodsucker." Its under lip is equipped with four tiny prongs which pierce the skin, after which the blood is sucked up through the beak. The effect of the bite of this insect varies with different individuals. It may cause little or no discomfort, or give rise to swellings and inflammation of the skin. The bedbug has been associated with the transmission of bubonic plague, typhoid, etc. A single female bedbug will deposit from 100 to 200 eggs at a time.

The cockroach exists in numerous households to a degree unsuspected by the housewife. Scientists have found that roaches are carriers of cancer germs. They are destructive and soil everything with which they come in contact, and in addition, leave an offensive odor which contaminates dishes, utensils, shelves and food.

One of the best ingredients for killing bedbugs and roaches is cresylic acid. The following formula, which is made by simply mixing the ingredients is a very efficient destroyer of bedbugs and roaches:

Kerosene	59.5 gal.
Oil of Citronella-Ceylon	0.5 gal.
Methyl Salicylate	0.5 gal.
Oil of Mirbane	0.5 gal.
Cresylic Acid (water white)	4.0 gal.

The Cresylic acid is light in color and has a distillation range that compares favorably with U.S.P. Cresol.

The kerosene used should have a minimum of odor and should be stainless. A practical test for "spotting" is made by placing a drop of kerosene on a white sheet of paper. This kerosene spot should evaporate completely in twenty-four hours.

Moth Spray

The following moth spray is stainless and has been used by some of the largest furriers for years:

Kerosene (water white)	25.0 gal.
Paradichlorbenzene	25.0 lbs.
Oil of Citronella (water white)	20.0 fl. oz.
Methyl Salicylate (water white)	35.0 fl. oz.
U.S.P. Cresol (water white)	25.0 fl. oz.

The kerosene should evaporate completely in twenty-four hours when a drop is placed on a white sheet of paper.

In order to get the paradichlorbenzene into solution, it is best to heat the kerosene and paradichlorbenzene together. The paradichlorbenzene dissolves readily in the heated kerosene and stays completely in solution when cool.

In conclusion, it may be well to state that all the above formulae are 100 per cent efficient. There is no inert matter present in them.

Cattle Spray

A cattle spray, regardless of its efficiency, must not burn or blister the hides of cattle. In addition, when used on cows it must contain no ingredients that will taint milk. The following cattle spray is especially effective against flies and also fulfills the above requirements:

Paraffin Oil	25
Pyrethrum Extract (Representing 20 pounds pyrethrum flowers per gallon extract).	3
Pine Oil	20
Mineral Seal Oil	52

The paraffin oil gives the following tests:

Flash	350
Fire	400
Viscosity at 100° F	100
Baume Gravity	28°

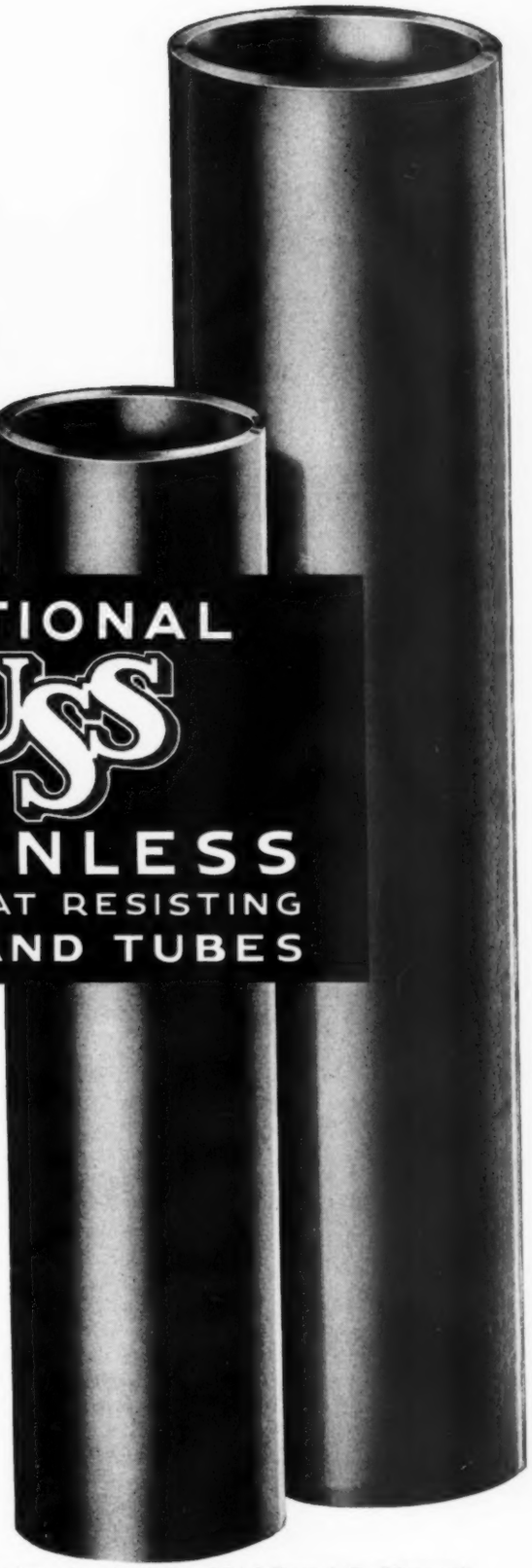
It is the ordinary 28° Pale Paraffin Oil and can be purchased from almost any refinery.

The pyrethrum extract can be bought at a number of reliable firms that deal in pyrethrum.

The pine oil is the ordinary steam distilled pine oil.

The mineral seal oil has a Baume reading of approximately 42 and can be purchased from practically any refinery.

Reducing the toll of CORROSION



NATIONAL USS STAINLESS AND HEAT RESISTING PIPE AND TUBES

.... in the Refining Field

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NATIONAL TUBE COMPANY

Frick Building, Pittsburgh, Pa.

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Centrifugal Pump Packing

By HAL T. WHEELER, President, Hal T. Wheeler Company

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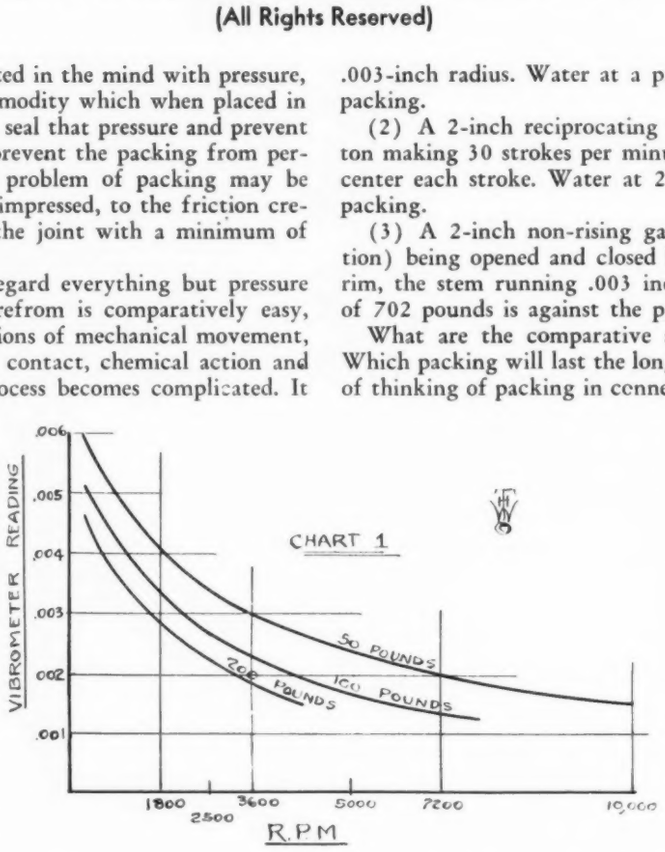
PACKING is always associated in the mind with pressure, and is thought of as a commodity which when placed in a stuffing-box will in some way seal that pressure and prevent leakage. If nothing occurs to prevent the packing from performing this simple task, the problem of packing may be stated as a relation of pressure impressed, to the friction created, the desire being to seal the joint with a minimum of friction.

To design packing and disregard everything but pressure and the friction resulting therefrom is comparatively easy, but when the operating conditions of mechanical movement, the velocity of the surfaces in contact, chemical action and the like are considered, the process becomes complicated. It is therefore advisable to subdivide the packing problem into two divisions: First, the internal influences, which are the movements of the packing due to the pressure relations within its structure that cause it to react against the shaft, thereby to seal the joint, and second, the external influences such as vibration of the shaft, bearing pressure and the like, which are acting against the packing. The two divisions may be described as action and reaction, which always occur in connection with each other, the reaction following the action.



Everyone admits that a true running shaft is best for packing performance; side movements of a shaft admittedly are additional loads for the packing to resist and do shorten its life and cause leakage. Included in mechanical movements is a species that is executed too rapidly for the senses to appreciate either their existence or their importance. These are termed vibrations, their source being outside of the packing structure and their effects being against and detrimental to the packing.

In a former article, the desirable advantages of the simple movements of a rotating shaft were contrasted to the adverse and accompanying vibration. Vibration was cited and stressed as the chief obstacle preventing the formation of a seal around a rotating shaft. And as vibration is a mechanical movement but slight in degree, methods were displayed for locating and measuring its effects. This information is summed up by Chart I, curves plotted at different pressures against the packing. The revolutions per minute and the permissible vibration throw, or the vibrometer reading, form the basis of these relations, which should be self-evident.

Vibration has not yet been recognized as a primary cause for packing failures on rotating shafts, except when it is present to such a degree that it is noticeable. To appreciate more definitely what vibration is and what it does to packing, the three following examples are given to illustrate the possibility of confusing the relations involved. The same packing is considered to be used for all examples.

(1) A 2-inch shaft rotating 3600 revolutions per minute and carrying a 50-lb. impeller, the machine center of the shaft traveling around the center-line of rotation in a circle of .003-inch radius. Water at a pressure of 5-lb. is against the packing.

(2) A 2-inch reciprocating rod attached to a 50-lb. piston making 30 strokes per minute and moving .003 inch off center each stroke. Water at 200-lb. pressure is against the packing.

(3) A 2-inch non-rising gate valve stem (rotating motion) being opened and closed by a 50-lb. pull at the wheel rim, the stem running .003 inch off center. Water pressure of 702 pounds is against the packing.

What are the comparative stresses against the packing? Which packing will last the longest time? Owing to the habit of thinking of packing in connection with pressure, the usual answers to these questions are: First, the packing in the gate valve stem (Example 3) is under the greatest stress on account of the 702-lb. pressure. Second, the packing on the rotating shaft (Example 1) will last the longest time, due to the low pressure of 5 pounds. Both answers are incorrect.

The packing on the rotating shaft is under the greatest stress and will last but a few hours, while that on the gate valve stem will last indefinitely and is under the least stress. The reasons follow:

(1) A 50-lb. impeller rotating at 3600 r.p.m. at a radius of .003-inch exerts a centrifugal force of 702 pounds against the packing, or any object which the shaft may touch. That is, a 702-lb. blow or contact is delivered against the packing 3600 times a minute; the 5-lb. water pressure in comparison is of no consequence.

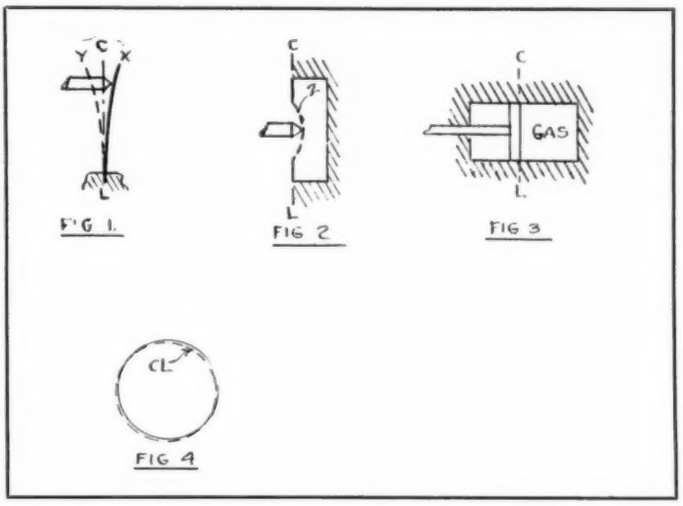
(2) The packing on the gate valve stem, while the stem is at rest, reacts against the 702-lb. water pressure sufficiently to seal the joint. When the stem is moved, only the 50-lb. pull exerted on the wheel as a side action is the possible force exerted on the packing.

The centrifugal force of 702 lbs., exerted by the rotating shaft is a destructive agent, while the 702-lb. water pressure has hardly any effect on the packing structure in the gate valve. Both values are expressed in terms of pounds force, yet the results are infinitely different. To anyone not acquainted with the various manifestations of force and energy the foregoing examples are confusing. It should be apparent that a movement off center of .003-inch (equal to the thickness of ordinary wrapping paper) in rotating work is very destructive and that vibration has an important part in determining packing stresses. Therefore, when considering such effects it is helpful to apply the correct name of destruction for this action. Destruction accomplished means that work has been done (force applied in some quantity per unit of time). All forms of vibration and the phases of packing reaction to these mechanical movements must be reduced to the amount of work done so that the packing problem may be understood.

Referring again to the three examples: on the rotating shaft a certain amount of work is done by vibration each

time for 3600 r.p.m. But the gate valve stem packing may stand for months, the only work being done is that due to a slight leak which is necessary to cause it to react and seal the joint, and when the stem is moved, the maximum amount of work is due to a 50-lb. pull at a slow rate of speed. However, it is not necessary for an operator to know how many foot-pounds of work are done by each vibration of a rotating shaft, this being cared for by Chart I.

The outstanding characteristic of any packing is its elastic capability. It must be sufficiently flexible to follow the motion of a shaft and at the same time press firmly enough to form a seal of greater resistance than the pressure impressed. Elasticity is that property of a body which causes it to resist any deforming action, then to cause it to recover its shape or size and to return most of the energy which caused the deformation. The term elasticity is usually associated with a material of uniform structure, such as spring steel or rubber, their elastic properties being secured by refinements and processing. But a ring of packing or a packing assembly is rarely ever of uniform structure and contains an infinite number of voids, joints and pores.



To appreciate whether packing can be considered as being elastic, it is better to compare several materials having characteristic properties, their reactions being of common occurrence. The value of these examples to this subject will lie in correctly relating their peculiarities so that a parallel may be established for considering packing in a like manner.

In each of the following examples a different material is subjected to the reciprocating action of a plunger that travels back and forth, one-half of its travel being on either side of the center line CL, the latter line shown being the original position of the material in question.

In Figure I, a slender reed of spring steel is firmly anchored. The plunger moves slowly back and forth deforming the reed to the dotted line XL. If the motion is very slow the reed will return after each stroke to the line CL, but no farther. As the plunger speed increases the reed will follow the plunger, moving between the lines XL and YL. When the plunger reversal becomes excessive, the reed will resist being moved and probably be broken off, unless the length is adjusted to permit the reed to vibrate in tune with the plunger movement. If the speed is great enough that the latter adjustment is needed, a steel of higher elasticity must be substituted.

Figure 2 is a slab of para gum rubber held against a background. The rubber will be compressed by slow plunger movement to the dotted line Z and will return each stroke to the line CL. As the plunger speed increases the rubber will lose its elastic rebound and stays deformed along the line Z. During excessive vibration, the rubber remains compressed and becomes rigid and hard, storing up the energy transferred from the plunger and not returning it.

Figure 3 is a cylinder containing a gas under pressure, the piston compressing it and then allowing it to expand the same distance. In this case, the slower the movement the more perfectly the gas will occupy the space behind the receding piston. Gas is sufficiently elastic that the piston must vibrate at a high rate of reversal to move faster than the gas can expand, yet this is conceivable. And at this point the pressure in the cylinder must be increased to obtain a higher elasticity. It may be noted that an elastic gas behaves oppositely to the first two examples, so far as returning to the original position.

The relations common to the three examples indicate that each material has a different way of resisting deformation. Each has a different rate of recovering its original size or position at the line CL. To increase the capability of reaction to vibration, some change must be made in the condition, position or composition of the material. And as each material has a given strength, each will refuse to react to vibration at some rate of deformation. Herein lies the importance of the amount and the rate of vibration of a shaft, as the material effecting the seal against pressure must be capable of reacting in tune with the shaft movement, or the shaft movement must be eliminated.

Nearly all packings for rotating shafts have a backbone of an inelastic and lifeless material, such as metal foil, asbestos or cotton. The fabricated structure is usually impregnated with an oil or a grease. None of the ingredients is elastic. An examination of Figure 4, the eccentric movement of a rotating shaft, indicates that if packing follows the eccentric movement it must have elastic properties. Where does any combination of inelastic substances secure a continuous elastic reaction such as is needed in Figure 4? Or does the packing really follow the shaft?

Packing on a slow-moving reciprocating rod is elastic because sufficient time is permitted for off-center movements. On high-speed rotation if the movement exceeds a few thousandths of an inch, or the rate of vibration exceeds a limit that is controlled by the packing material, the packing is not and cannot be elastic.

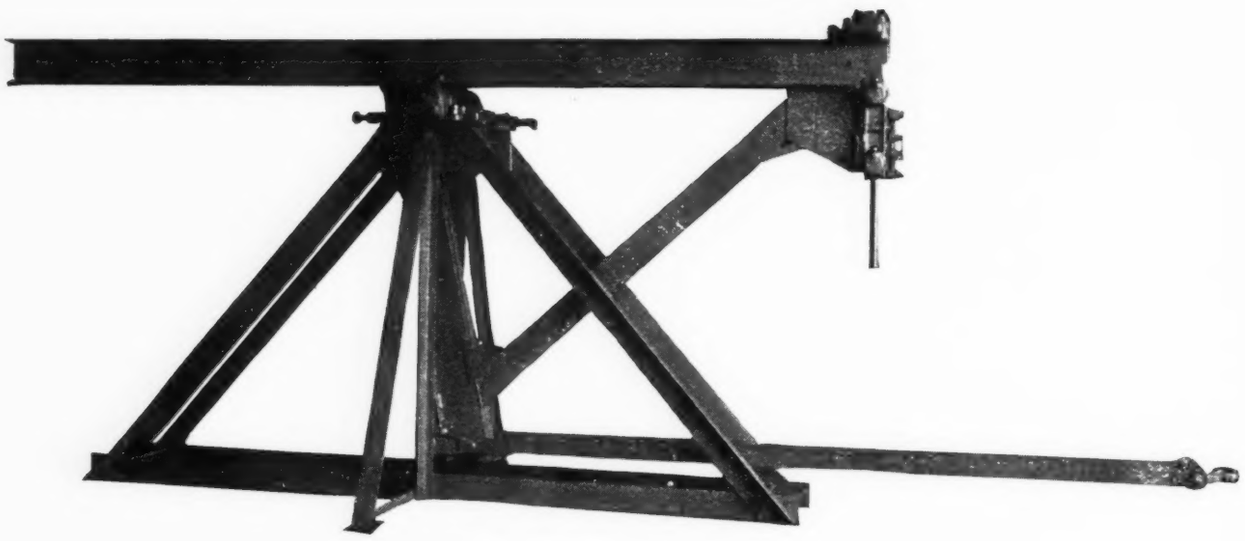
The formation of new surfaces on sleeves is the answer: Packing seeks a surface free from vibration. This means that the area of contact must turn around the center of rotation. Soft sleeves will be cut and worn so that a new cylindrical surface is formed concentrically with the center of rotation —not the shaft center. If the sleeve is too hard, the packing will be torn to pieces in its endeavor to establish a true-running surface. The amount of "throw" as shown by the Vibrometer will equal the eccentricity of the newly-formed surface with respect to the machined surface of the shaft or the sleeve.

"Molasses in January" is very elastic as compared to packing being subjected to vibration. The reaction of packing to continual high-speed blows is identical to the rubber of example 2; it is permanently pushed away from the shaft, becomes rigid and hard and wears the high point of the shaft until new and a true rotating surface is formed. Then sealing will take place, if the sleeve is not too rough from the period of cutting.

To seal a shaft during periods of vibration, packing must alternately be compressed and then expanded to maintain a seal. Since its action is identical to rubber and loses its elastic capability at high rates of vibration, it would appear that it must take on the characteristics of a perfect gas—unlimited compressibility and expansibility. An inelastic structure cannot have the characteristics of a gas, so it would appear that the problem can be easier handled by removing the shaft eccentricity.

NATIONAL PUMPING JACKS

TYPE D-100 & D-130



All-steel, arc-welded construction, and designed for long-stroke pumping of deep wells. Entirely self-contained and self-supporting; with excess strength and extreme rigidity, these National Jacks provide economical installation, efficient operation and long, dependable service.

Bulletin No. 1032-B free on request.

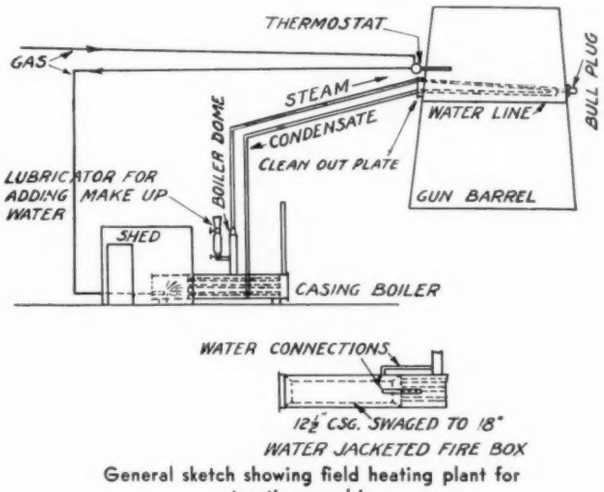
THE NATIONAL SUPPLY COMPANIES

Gun Barrel Heater for Treating Emulsions

PRACTICALLY every engineer interested in treating oil-water emulsions, or, as they are commonly termed, B.S., has had at one time or another some form of heater. On the accompanying illustration is shown a heater of this type that is giving good service in the El Dorado district, Kansas.

Its construction is simple. The boiler shell is made from a piece of 18-inch or other large casing of some convenient size. Two flue sheets are welded in the shell and the necessary number of flues to handle the production are welded into the sheets. In order to leave space for the stack connection, the stack-end flue sheet is welded about one foot in from the end of the shell. After the back flue sheet and flues have been welded in place, the firebox, of the same size casing as the shell, is welded to the shell. In the first heaters made, a liner was set on lugs in the firebox to protect the outer shell. This liner was made from a length of casing of the next smaller size to that of the shell. The firebox is usually about four feet long. It should be long enough to keep the gas flame off the flue sheet. In some of the later heaters the firebox is water jacketed by swedging out the liner at the ends to fit the shell, to which it is then welded. The shell and the outside of the firebox are then connected by outside lines.

The dome of the boiler is connected to a coil in the gun barrel and a return line from the coil is connected into the side of the boiler, thereby forming a closed steam circulation system. The coil, of course, must be above the boiler. If all connections are tight, one filling of the boiler will last indefinitely. However, a lubricator is welded into the side of the dome for adding make-up water. The normal working water level of the boiler is half way up in the dome.



General sketch showing field heating plant for treating emulsions

It is not necessary to get inside the tank when installing the coil if the procedure here outlined is followed. Draw water from the gun barrel until the oil level is below the point where the coil is to be installed. A clean-out plate with half Dresser sleeves welded into it is then bolted to the tank. The coil usually consists of only one loop. A 3-inch flange is attached to the side of the tank diametrically opposite the clean-out plate. A joint of 2-inch pipe is then run through the 3-inch flange and screwed onto a short 2-inch nipple welded to the coil. The coil is then drawn across the tank until the 2-inch nipple, which is welded to the coil, rests in the 3-inch flange. The joint of 2-inch pipe is then unscrewed from the short nipple and a bull plug is screwed into the 3-inch flange. The clean-out plate is then bolted on the opposite side of the coil ends through the half Dresser sleeves that are welded into the plate. After making up the packing glands the production is turned back into the gun barrel. This job can be done in four to five hours' time. The principal point to watch is to give the coil sufficient slope so that it will drain to the boiler.

All lines and the boiler shell should be well insulated. The firebox, unless it is water jacketed, is insulated with clay or earth.

It can be conveniently installed in a gun barrel tank without the necessity of anyone entering the tank, and with only a very short interruption in operations.

The only metal that comes in contact with salt water is the coil in the gun barrel, and this can be replaced at very small cost.

No water line to the boiler is necessary, as the same water is used over and over again, being evaporated and condensed in a closed system, a system that also keeps the boiler free from scale.

The thermal efficiency is high, being about 65 per cent.

By installing the coil high in the gun barrel tank no heat is lost from the siphon. Only the top of the gun barrel is heated. In gun barrels that operate 24 hours a day the coil can be set below the water line in the gun barrel tank, as the incoming oil carries the heat upward. In gun barrels that do not operate 24 hours a day the coil should be placed in the oil, otherwise the heat will go downward and part of the heat will be lost out through the siphon. Some may object to this type of treatment as no provision is made for washing the oil through hot water. But unless the oil be very viscous, a hot water wash is found to be necessary.

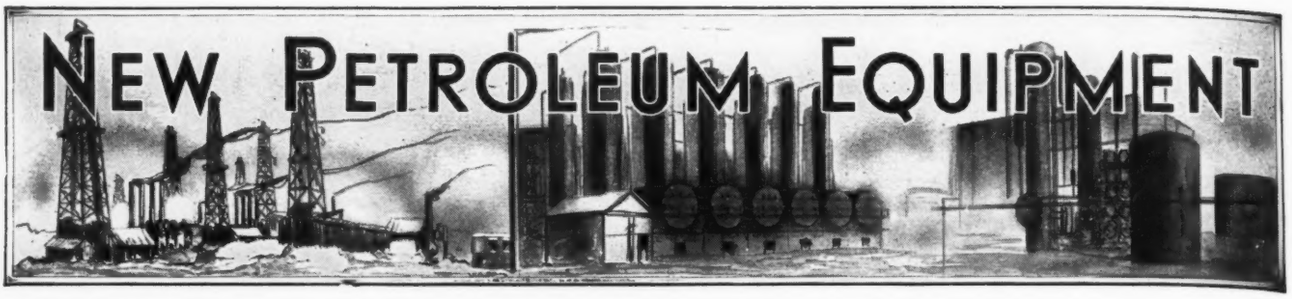
There is less danger of fire than with direct fired heaters. A safety valve and steam gauge protect the heater.

The size of the plant depends, of course, on the production to be handled and the rate at which it is handled. On one installation that works very satisfactorily the boiler heater handles about 5 barrels per 24 hours per square foot of heating surface. If necessary, this heater could handle with ease two or three times this quantity, but at the expense of thermal efficiency.

The coil in the gun barrel, which is a 16-ft. x 16-ft. wooden tank, consists of one loop of 2-inch pipe. With it, the temperature of twenty barrels of oil can be raised from 60 degrees F. to 70 degrees F. in 24 hours per square foot of coil surface, or a total of 300 barrels per day. For this rate of performance a steam pressure of 20 to 25 pounds is required.

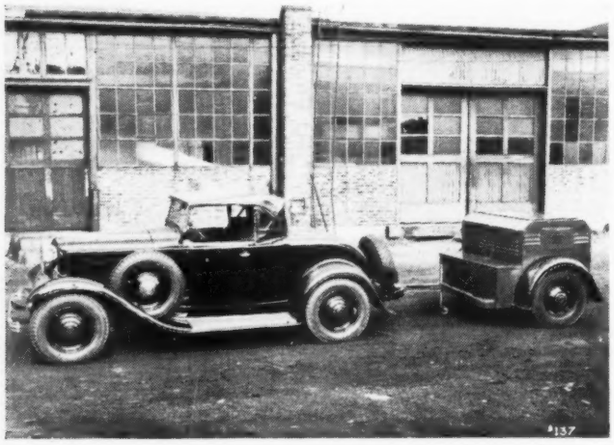
In the installation just described the production was uniform over the total 24 hours. If the production were not uniform a larger coil would be necessary to prevent excessive boiler pressure being used.

An installation as herein described has been operating steadily for more than a year with absolutely no trouble, nor is any trouble anticipated other than the occasional replacement of the coil in the gun barrel. It is free from the troubles encountered with direct fired heaters that require considerable maintenance owing to the action of salt water and have their efficiency reduced because of scaling.



Shunt Inductor Principle Contributes to Efficiency of New Trailer Arc Welder

UNIVERSAL Power Corporation, of Cleveland, Ohio, in developing their new V-8 engine-driven 300-ampere Arc Welder of high speed portable trailer type, have used the shunt



inductor principle for arc stabilization, similar to that used in their motor generator sets.

The combination of the shunt inductor coupled with the smooth flow of power of the V-8 engine has effected a gas driven arc welder performance of unusual stability and flexibility, and being mounted on two-wheel "donut" tires has produced, according to the makers, a welder long needed in the field of structural steel erection, pipe line extension and general maintenance and repairs.

Universal High Road Speed Trailer Arc Welders have many other features contributing to their usefulness and efficiency. The novel mounting of the horizontal radiator directly over the engine, with blower type fan, materially effects the cooling of the entire unit. A sliding cover over the radiator allows for proper amount of radiation and cooling regardless of temperature conditions.

The accompanying illustration shows Universal High Road Speed Trailer Arc Welder coupled with a standard V-8 roadster with which the company is demonstrating and making deliveries to its customers.

National's New Geared Pumping Power

THE line of geared and band wheel pumping powers manufactured and marketed by The National Supply Companies has been increased by the addition of a new geared power known as Type G-100.

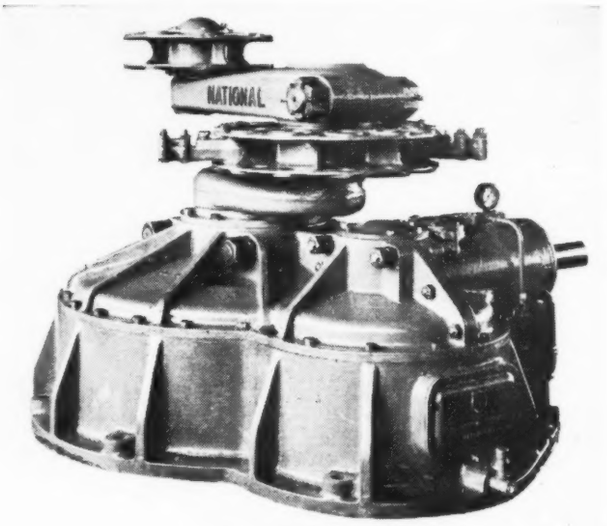
The power has been designed for the economical pumping of deep wells that ordinarily would require standard rigs and individual engines. It is especially suitable for those operating conditions demanding a more compact installation than National's 15-C Band Wheel Power.

For moderately high pumping speeds, the G-100 Geared Power is rated at 100-h.p. The lower crank has a 36-inch stroke with twelve well connections; upper crank stroke is thirty inches, with positions for eight well connections.

The double reduction gearing is entirely enclosed in a rigid housing, oil-tight and dirt-proof. The gearing has been designed with large diameter, wide-faced pinions, securing low bearing pressures. Gears are alloy steel, generated by Gleason and by National, which insures highest quality and workmanship.

Every bearing in the G-100 Power is a Timken, selected, in coöperation with Timken's engineers, to give a high factor of safety. An especially notable feature is the wide bearing spacing to handle the overhanging loads on the pinion shaft and the crankshaft. Extremely rigid mountings have been provided to maintain correct alignment.

Lubrication is by a simple gear-driven pump enclosed in the housing. The lubricant is Purolator filtered, and an abundant



supply of clean oil supplied under pressure to every part of the enclosed transmission.

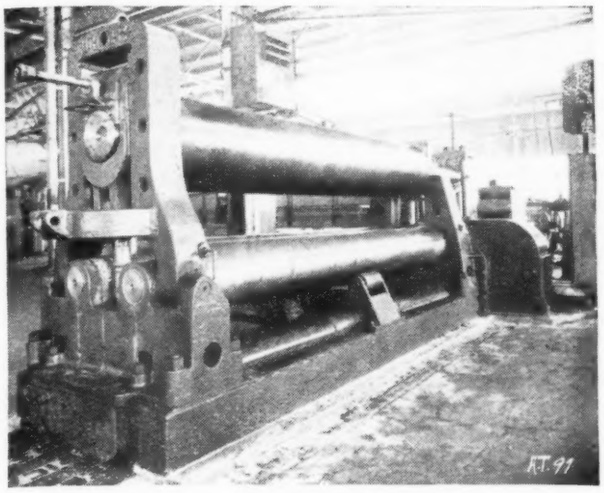
The G-100 Geared Power has been designed with a rich background of experience in building efficient pumping powers and reduction gears. It provides an installation of low initial cost, and years of dependable, care-free service are assured.

Large Set of Plate Bending Rolls

PROBABLY the largest set of plate bending rolls in the Mid-Continent have been installed in the modern welded pressure vessel plant of the American Tank & Equipment Corporation, Oklahoma City, manufacturing subsidiary of Black, Sivalls & Bryson, Inc. This powerful machine, which is capable of bending a boiler plate 1¾ inches thick and 12 feet in width, into a shell 36 inches in diameter or larger, was specially manufactured for the exacting work of rolling pres-

sure vessels truly round for butt welding by the Baldwin-Southwark Corporation of Philadelphia, Pa.

This roll, which represents the very latest development in an exceptionally powerful and efficient machine to accurately form plates of unusual thickness, contains many unique and interesting features. Two separate large motors are required to operate it. The first of these, a powerful 60-horsepower, slow speed, drum controlled slip ring motor, slowly but powerfully rotates the two bottom power rolls through a totally enclosed train of accurately machined herringbone reduction gears, which are continuously lubricated by a flood of oil from a motor-operated pump. The second of these, a 50-horse-



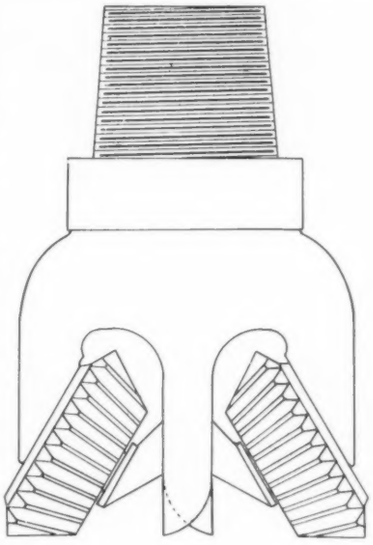
power slip ring motor, controlled from a separate drum controller, operates the powerful screw-down mechanism through a pair of totally enclosed, oil immersed worm and worm wheels that rotate the nuts of the large tension screws supporting the big top roll. Some idea of the unusual power of this machine can be had from the statement that this screw-down mechanism is capable of exerting a downward pressure of 600,000 pounds upon the massive 25-inch diameter, solid forged top roll—a pressure sufficient to bend any plate within the capacity of the machine and wrap it close up around this top roll, which itself is a forging weighing more than 20,000 pounds.

New Combination Drilling Bit

THE Brewster Company, Inc., Shreveport, La., announces a new combination drilling bit, patent for which is pending.

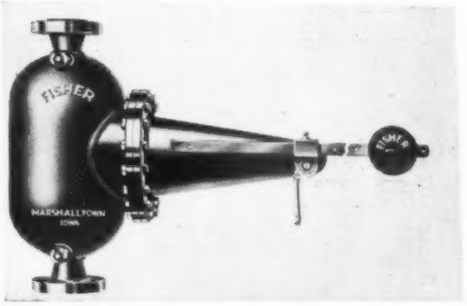
The bit is designed to cut either hard or soft formations, being equipped with rollers for the harder drilling conditions, and certain peculiarly shaped cutters for soft digging.

The center blade, which is a fish-tail bit set with Carbolite metal, is said by the manufacturers to be flushed at all times by the pump pressure to enable it to keep the cones perfectly free when in soft formation, or to prevent the cutters from becoming fouled when drilling gummy formations.



New Fisher Liquid Level Controller Float Cage

A NEW development in the construction of Liquid Level Controllers has just been announced by the Fisher Governor Company, through the introduction of the Drawn Steel Float Cage.



This float cage is for use where a float outside the tank or tower is required to operate a lever valve, pilot valve, indicator device, or switching mechanism.

Years ago Fisher pioneered this line of equipment by developming the float cake controller, and they have heretofore manufactured the cages in sizes for six-inch float, eight-inch float, and ten-inch float, for three different pressures—125 pounds, 250 pounds, and 600 pounds, the last of which was cast steel, the first two cast iron.

The new drawn steel cage is announced after eighteen months of experiments, research, and factory development. This cage is made of open hearth flange quality steel of a tensile strength of 65,000 pounds per square inch. Hot and cold forming operations are used, and the nipple on the cage body, as well as the drop forge steel flanges on top and bottom of cage, are made an integral part of the unit by a unique welding process.

The drawn steel cage continues the feature originated by Fisher in that there is a bolted flange of high pressure boiler plate material between the cage body and arm, permitting removal or inspection of the float without removing the cage from the tank or tower.

The drawn steel cage is suitable for high pressures and temperatures, 610 pounds at 600 degrees F., or 410 pounds at 900 degrees F. It is equipped with the exclusive Fisher ball bearing grease seal stuffing box, and KA-2 stainless steel ball float. Top and bottom equalizing connections are drop forged steel flanges. Wall thickness is absolutely uniform—greater safety.

This cage is stronger, yet 60 per cent lighter in weight, than the same pressure cast steel cage. This feature alone means an appreciable saving in shipping charges and installation costs.

The Fisher Governor Company, Marshalltown, Iowa, will be glad to send the new Bulletin 37 covering this.

Thru-Port Valve

THE Reading-Pratt & Cady Company, Inc., Bridgeport, Conn., announces the Thru-Port valve, said to be an entirely new idea in valve design. It is particularly recommended for refinery and other services where coking or similar troubles are encountered, as it can be cleaned by running a rod through the line.

The valve is precision turned from high quality carbon steel. The stems are especially treated for high temperature service. The renewable slip-on disc for stainless steel is free on the stem to prevent sticking in the body and galling of seating surfaces. It is made non-rotatable to prevent possibility of horizontal scratching of the seating surfaces. When wide open the disc is entirely out of the fluid passageway. Body, bonnet, packing nut, and gland are Parkerized for protection against corrosion. A relief passage is provided for the escape of fluids caught under the plug as it closes.

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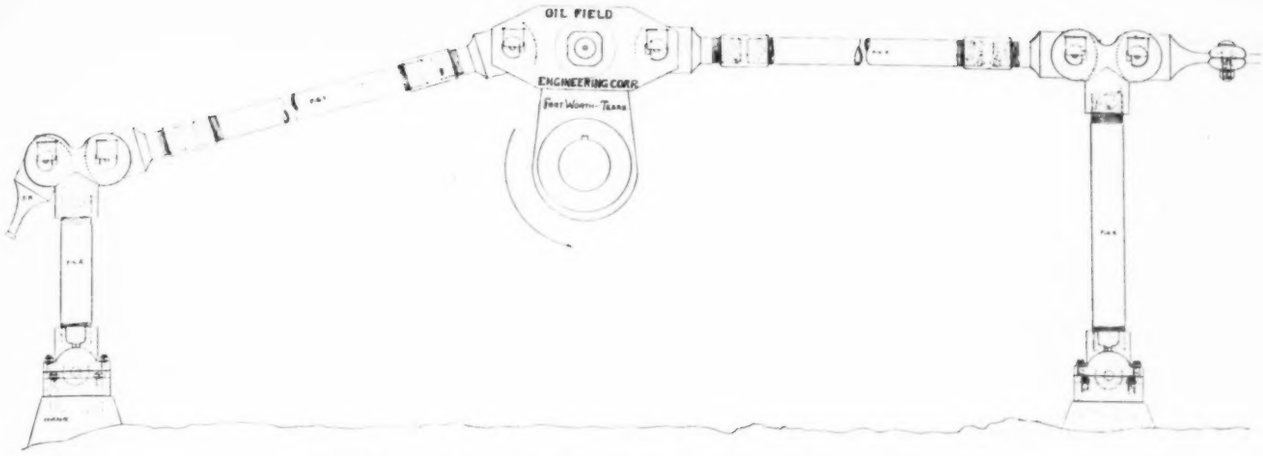
PUDDLED IRON SUCKER RODS

Science and Invention Have Never Found a Satisfactory Substitute for Genuine Puddled Iron



Ofeco Back Side Crank Pumping Unit

Oil Field Engineering Corporation of Fort Worth, Texas, has developed the Ofeco Back Side Crank Pumping Unit to meet the present measures of economy practiced in oil production and to utilize power that was formerly wasted.

The Ofeco Unit is designed to be of special value to line wells where a central power is impractical. One well, under this method, can be standardized and from two to four additional wells balanced, all on the Ofeco Unit. Addition of these extra wells is figured, from field tests, to add little cost over that of the original well.

The Ofeco Unit, according to the manufacturers, has the capacity for handling 4,000-foot wells. Information on installations made and on the various applications possible will be furnished on request.

The Ofeco Unit is made entirely of steel. All moving parts are bronze bushed with tooled steel connection pins. All parts are over-sized and ruggedly built to last the life of the well. Replacement pins and bushing may be quickly installed without shutdown of the wells.

The Ofeco Back Side Crank Pumping Unit incorporates the Ofeco Wilcox Wrist Pin in connection with its assembly.

International Trucks to Iraq

A fleet of sixty-four International motor trucks and also a fleet of sixty-eight specially equipped McCormick-Deering tractors were recently purchased by the Iraq Petroleum Company, Limited. This equipment will be utilized in the difficult construction of two pipe lines which will take oil from beyond the Tigris River in Eastern Iraq across virtually uninhabited and trackless desert to the Mediterranean. The pipe lines will run parallel for 150 miles in a southwesterly direction from Kirkuk to Haditha, just west of the Euphrates River, and one line then will go northwest for 381 miles to the port of Tripoli in Syria and the other southwest for 468 miles to the port of Haifa in Palestine.

In the day-after-day transport of essential supplies across this rough desert country with its lack of roads, scarcity of water, high temperatures, occasional deep creek or river beds (wadis), salt marshes, etc., automotive equipment will have to prove its mettle in a variety of most difficult tests. Grades are frequently steep and a considerable portion of the country to be traversed is covered with lava rock and highly abrasive sand and dust, which add their own peculiar difficulties to smooth mechanical operation. This lava rock is mostly in the form of boulders from one-half foot to two or three feet thick as shown in the accompanying illustration. The sand under these rocks is loose and removal of the rocks does not help much in the construction of roadways.

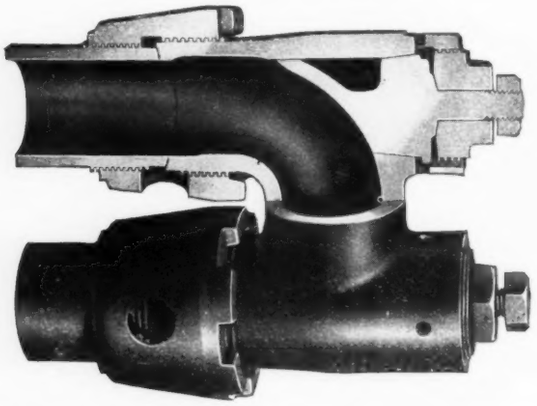
Of the sixty-four International motor trucks that will be utilized in this Iraq project, forty-eight of the units are Model B-2 one and one-half-ton six-speed special motor trucks of 136-inch wheelbase; nine Model A-4 two-ton speed trucks, four of which are equipped with winches; five Model A-5 three-ton speed trucks; one Model A-7 five-ton heavy-duty motor truck; and one Model A-8 seven and one-half-ton heavy-duty motor truck. The fleet of tractors on the project will include sixty McCormick-Deering 10-20 and eight 15-30 industrial tractors, all of which will be fitted with crawlers and pipe line handling equipment. For some years the Iraq Petroleum Company, Limited, has been an important user of International trucks, and with the sixty-four Internationals mentioned above and those used on other work, its total purchases of Internationals now consists of over 100 units.

The Iraq Petroleum Company, Limited, which is made up of interests from several countries, including British and American groups, has pledged itself to complete the pipe lines described by the end of 1935. When completed, the two lines will have a daily capacity of 85,000 barrels. The main pipe lines will be of 12-inch seamless tube with welded joints, and some 120,000 tons of pipe will be required.

A New Series of Fittings

THE Key Boiler Equipment Company of East St. Louis, Ill., announces its new series 6500 fittings for use on cracking stills, tube stills and condenser coils.

These fittings are attached to the tubes or pipes by means of differential thread sleeve couplings, which eliminate the



necessity of rolling the tubes into the fittings. Convenient access to tubes for cleanout or inspection is provided for by closure plates with tapered joints. These closure plates are held in place by powerful holding devices and are equipped with deflectors to provide full stream line flow through the fittings. Illustration shows the return bend fitting, but the complete series includes fittings for any form of tube layout or assembly.

Oil Industry Cleaner

ME-TERJ-OL is a highly concentrated cleaning agent for steel drums, tanks, cars, storage tanks, preheaters, heat exchangers, pipe lines, tank steamers, oily floors, valves and metal parts.

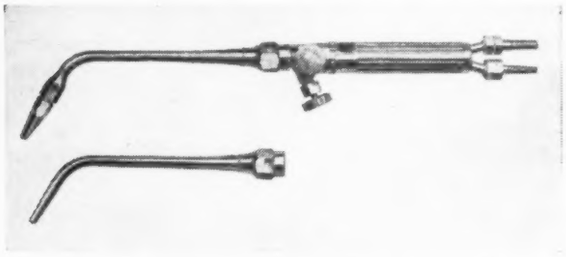
The manufacturers claim that Me-Terj-Ol is instantly soluble and miscible in water and that it reaches its maximum detergency at a temperature of 125 degrees F. It is said this cleaner also mixes readily with salt water, which permits using it at sea.

The manufacturers further claim, that this cleaning agent will go the full length of the steam flow in a vaporizing system; moreover, that it will not cause a burn if accidentally gotten on the skin.

This cleaner is made by the Me-Terj-Ol Products, Inc., Empire State Building, New York City.

Oxweld Blowpipe

THE Linde Air Products Company, 30 East Forty-second Street, New York City, has announced a new welding blowpipe, designated as the Oxweld Type W-22. Although



developed primarily for use on pipe lines, its application is not restricted to this field.

The new blowpipe is very similar to the Oxweld Type W-17 Welding Blowpipe except that the oxygen and acetylene valves are located on the front of the handle, so that flame adjustments may be made more readily by the operator while the blowpipe is in operation. This valve is located on the left side of the front of the handle where the operator's right thumb can conveniently regulate it.

The oxygen valve is located on the under side of the handle where it may also be easily reached. This arrangement makes it unnecessary for the operator to use his left hand, which is holding the welding rod, to adjust the valves.

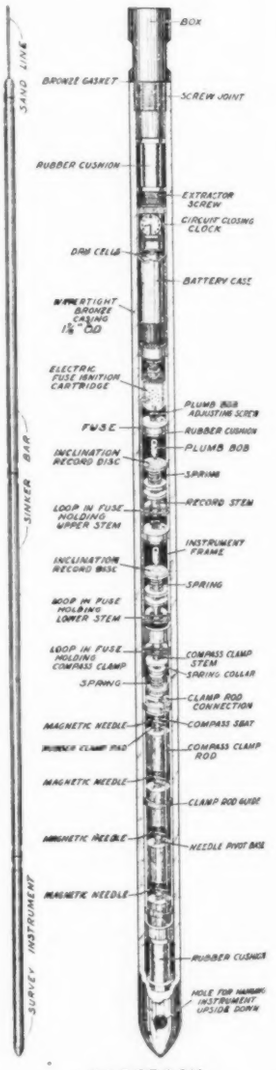
A special feature of the blowpipe is the long acetylene passageway between the acetylene valve and the injector, which minimizes the possibility of flashback. This is accomplished by having three acetylene tubes between the rear and the front bodies. The ball-type acetylene valve is another feature. It consists essentially of a stainless steel sphere which is hardened and ground with extreme accuracy by a new process. This sphere gives a narrow line of contact and eliminates any difficulties which might be caused by the deposition of carbon in the valves.

Anderson Single-Shot Magnetic Survey Instrument

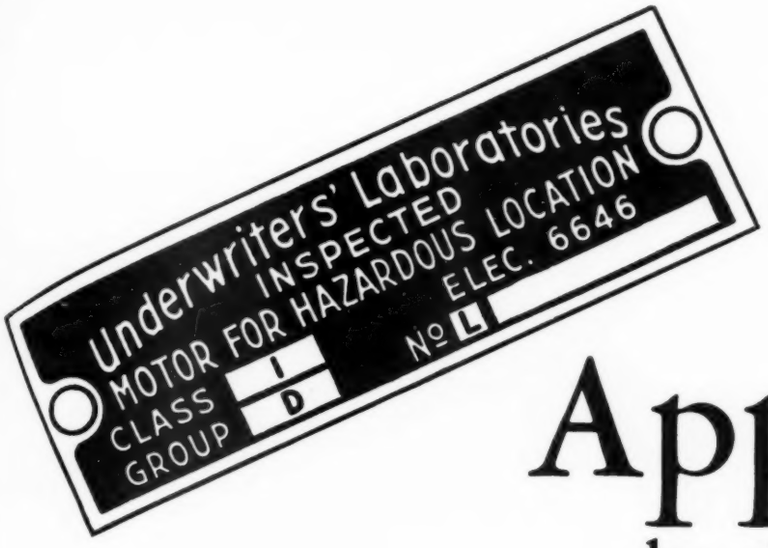
A NEW self-checking directional oil well survey apparatus which gives both the amount and the direction of hole deviation at any time during drilling has recently been brought out by Alexander Anderson of Fullerton, Calif. This new instrument is designed to be operated on the sand line by oil company employes without any outside technical help and is being leased to oil companies with great success.

As shown in the illustration, the apparatus is housed in a bronze outer casing that is only one and seven-eighths-inch O. D. It is run either on a twenty-foot sinker bar or directly beneath the bailer. When used with a sinker bar it may be run in open hole or lowered inside the drill pipe; but in the latter case the bit must have a hole through it big enough to permit the apparatus to project through and below the bit while the reading is being taken.

The instrument has two identical inclination recording units which make independent records of the inclination and thus provide a complete check of the accuracy of the angle given. Below these units are four independent magnetic compasses each of which comprises a jeweled free-swinging magnetic needle that is constructed to always swing in a horizontal plane at all positions of the instrument. The light weight and free method of mounting the needles assure their perfect operation and prevent damage to them through hard use.



ANDERSON SINGLE SHOT MAGNETIC SURVEY INSTRUMENT



Approved

by the Underwriters' Laboratories

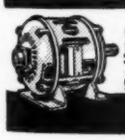
CONDUIT BOX is of cast-iron, tightly held together by four bolts. It has a threaded opening for rigid-conduit connection. The passage between the frame and the conduit box is sealed, and the conduit box is so constructed as to prevent escape of flames should explosions take place within the box or the rigid conduit
THRU BOLTS are eight in number, double that used in the totally-enclosed fan-cooled CP motors. They are also of suitable size to prevent loosening of end-plates or escape of flames thru the endplate fits, which might otherwise be caused by explosions inside of the motor
CARTRIDGE-type bearing housings permit removal of the rotor shaft - bearings assembly without in any way exposing the ball bearings to the surrounding atmosphere. Thus the bearings are safeguarded against dust, fumes and moisture at all times
ENDPLATES are extra strong to withstand internal explosions without cracking or shattering
Shaft, Stator Core, Rotor, Bearings, Winding, Insulation, Feet and other items which do not differ in general design and construction from those contained in open-type HP motors, are already fully described in Part 1 of this bulletin, and are therefore not redescribed on this page
VENTILATION is thoro—sufficient to keep the motor from reaching a temperature high enough to ignite surrounding gases, even under abnormal operating conditions. The stator periphery is provided with ripping the cooling surface. At the shaft-end a deflector is provided to guide the cooling draft around the bearing at that end
A full discussion of the subject of totally-enclosed fan-cooled motors will be found on pages 5 to 10 of Part 5
FAN is of one-piece, cast-aluminum construction, will not produce sparks when accidentally hit by metal
STATOR FRAME consists of the stator punchings held tightly between two end-rings—a special construction being used to obtain a wide fit between core and rings. It is of such construction as to be able to withstand explosions of flammable substances inside the motor
BEARING HOUSINGS have ample strength to withstand explosions, and extra long shaft fits to prevent escape of flame from the motor
MACHINED FITS are extra long to prevent the escape of flames (produced by internal explosions) to the surrounding atmosphere. These fits are between the stator frame and the endplates, between the endplates and the cartridge bearing housings, and between the bearing housings and the shaft
END SHIELD is of cast iron or formed steel. The grating is an integral part of the shield. No wire mesh is used because of its susceptibility to rapid erosion in unfavorable atmospheres and its lack of rigidity and consequent inability to protect the ventilating fan
WAGNER ELECTRIC CORPORATION, ST. LOUIS, U. S. A.

A page from Bulletin 174. Ask for a copy.

Wagner type HP motors for hazardous locations are specially sealed, reinforced and proportioned to meet the hazardous atmospheric conditions prevailing wherever gasoline or natural-gas is produced, transported, and stored. They lower installation and maintenance costs—require no shields and fire walls, are protected against dust and moisture. Write for Bulletin 174 on Wagner squirrel-cage motors, in Part 5 of which these Underwriters-approved motors are completely described.

WAGNER ELECTRIC CORPORATION
6408 Plymouth Ave., St. Louis, Mo.

Wagner Electric



MOTORS
Complete line..alternating current...1/30 to 400 horsepower... 25,000 type-horsepower-speed combinations...latest mechanical and electrical designs.

TRANSFORMERS
For every service, indoor and outdoor ... single and three-phase ... power, subway, network, instrument, distribution, air-cooled, underground, etc.

FANS
Wool-yarn lubricated 8, 10, 12 and 16-inch desk-bracket....ceiling, ventilating, furnace... alternating current, induction motors.

BRAKES
Lockheed Hydraulic for automobiles, buses, trucks, trailers, taxicabs ... National chain of factory and authorized stations completely service all brakes.

L532-3

Fusion Welding for High Pressure Work

By G. W. PLINKE☆

THE demands of designing engineers of power boilers and refinery vessels have continually been for high pressures and greater temperatures to increase efficiency in operation and production. For this reason, in anticipation of the change in method of construction, manufacturers of pressure vessels by practical experiment and laboratory research sought ways and means of supplementing and, if necessary, superseding riveted joints. Welding by the oxy-acetylene torch and electric arc was the outcome of this work.

This early development work was being done long before the adoption of a welding code but it was realized by fore-thinking manufacturers as well as by liability insurance companies that a code was necessary. So with their joint support the American Society of Mechanical Engineers condensed into the present Code for Unfired Pressure Vessels the years of effort and experiment of these pioneers.

A relatively short experience determined the necessity for extreme care in welding procedure. All welding in the early stages was done with what is known as bare wire and to develop a satisfactory weld for the comparatively light pressures then considered safe, the wire was most carefully selected for quality, the plate thoroughly prepared for the weld and finally the welder most closely supervised. The object of this close supervision was to make a sound weld that as nearly as possible would have all the characteristics of the parent metal itself in tensile strength, ductility, micro-structure, resistance to shock and specific gravity.

As an improvement over bare electrode welding it was believed that a flux coated electrode was much better, but very exacting research work was necessary before a flux was developed which met all requirements. The flux must give absolute protection to the arc, shielding it from any combination and the atmospheric gases. It must also form a protective coating during the solidifying and cooling of the metal, and also have a stabilizing effect on the arc and prevent any disturbance in the molten metal.

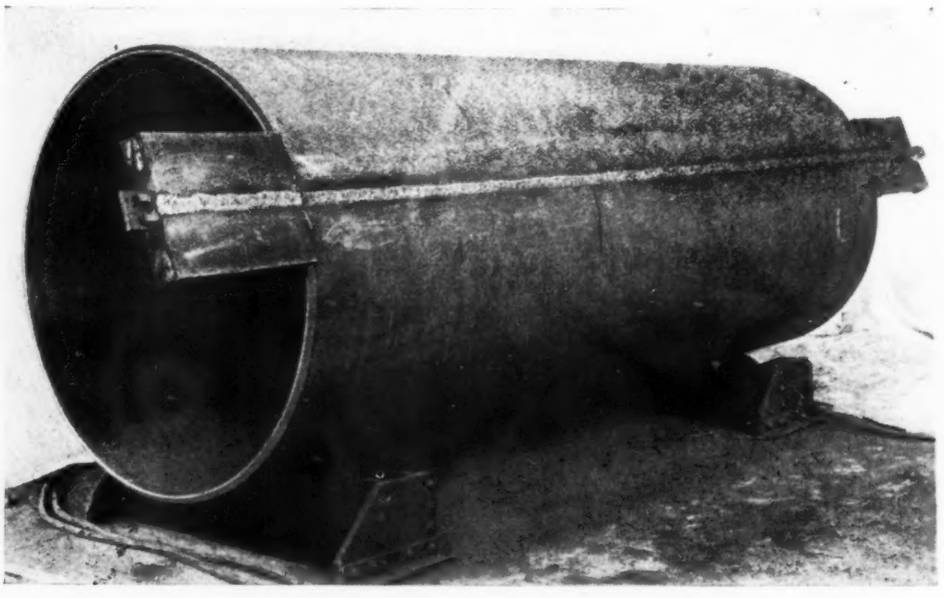
The development of the proper flux for the electrode was a long stride toward the improvement of the weld metal.

It was, however, equally as important to develop the proper technique in welding with the covered electrode, and establish a well-defined and exacting procedure control. After innumerable tests of every description it was proved that through the use of the properly covered electrode and by following the proper welding technique the physical qualities of the deposited weld metal are materially improved. Weld metal of this type possesses high tensile strength, good ductility, high impact values, specific gravity consistently better than the parent plate, and is free from microscopic imperfections such as nitrides and oxides. There is no application of welding that requires more complete control and exacting supervision, together with a definite procedure than does the welding of pressure vessels. It was evident that the Code committee had this thought in mind in the formation of the requirements as set forth in the regulations for fusion welding for Fired and Unfired Pressure Vessels. Therefore, it is necessary to use only qualified welders on all pressure vessel work. For class 1 construction each welder qualifies as the work is being fabricated. Two sets of test plates from steel of the same specifications and prepared for the welding in the same manner as

THIS MONTH'S COVER

Reproduced on the cover this month is a photograph showing a battery of nine high-pressure absorbers, 4 feet in diameter and 41 feet 8 inches high, located at the Fritch, Texas, gasoline plant of the Natural Gas Pipe Line Company of America. At this plant natural gas is treated for transportation to Chicago through a 24-inch line. Embodying most modern engineering features, the plant is designed to treat 175 million feet of natural gas per day at a pressure of 610 pounds per square inch.

☆Research Engineer, Henry Vogt Machine Company, Louisville, Ky.



Test Plates of the same specification steel and welded in the same manner as the work

When You Are Ready

. . . I AM

I *Have* N*ot* *Quit* P*ipe*-L*ining*

Ready TO give you the same good work and Keep our reputation of long standing: to Lay any size, any length, anywhere, And . . . . if you want a quick job . . I Have available sufficient equipment and Organization to assure you of the Most possible speed without the loss of Any efficiency. , ,

OKLAHOMA CONTRACTING CORPORATION

T. R. [TOM] JONES

DALLAS, TEXAS

the work are attached to the drum or vessel and welded in the same manner and at the same time as the drum or vessel which is being welded.

For class 2 and class 3 construction each welder is required to pass standard qualification tests conducted every six months. A record of these tests is kept on file and is subject to inspection at any time by the insurance companies' representatives or purchasers' inspectors.

In the welding of the longitudinal and circumferential seams of boiler drums and pressure vessels, welding machines of special design are used. With the use of such machines the same high grade of deposited weld metal is maintained for each layer of weld in the entire seam and is far more uniform than that obtained by ordinary hand welding. On completion of each bead the slag coating covering the deposited weld metal is removed by light blows from a caulking hammer. The weld layer is then brushed with an electric motor driven wire brush and all traces of slag are removed, leaving only a bright, clean deposit of weld metal which has fused into the walls of the weld channel of the adjoining plates. Successive beads laid one upon the other have the effect of annealing the ones previously laid, and cause a definite grain refinement in the weld metal.

Nozzles, manheads and miscellaneous fittings are applied to the boiler drum or pressure vessel by hand welding, since in the majority of cases it is impossible to use machine welding. The same care and supervision, however, is exercised in the welding of fittings as is maintained on the seams of the pressure vessels.

Although the technique of welding is such that the deposited weld metal is of assured quality, the class 1 constructed pressure vessel is also subjected to X-ray examination of the welded seams.

This X-ray examination is accomplished by the use of a 340-kilovolt duel type X-ray machine, equipped with two Coolidge tubes. This dual type construction enables the operator to X-ray two radiographs simultaneously on the longitudinal seams at each set up. The current is rectified through the use of two Muller Metalix valve tubes. The two Coolidge X-ray tubes are mounted in a lead drum which can be moved forward, backward, or raised and lowered, which makes the equipment very flexible and enables the operator to obtain quick and accurate set up. The high tension transformer and X-ray equipment are mounted in a carriage provided with car wheels and this carriage can move forward or backward on one set of tracks which parallel the turning mechanism that carries the boiler drum or pressure vessel.

X-ray examination gives a very positive record of the presence of mechanical defects, particularly porosity, undercutting and slag inclusions in the weld metal.

The radiographs are made, using a standardized procedure, in which all conditions affecting the quality of the picture are held constant as far as practical during the examination of the weld.

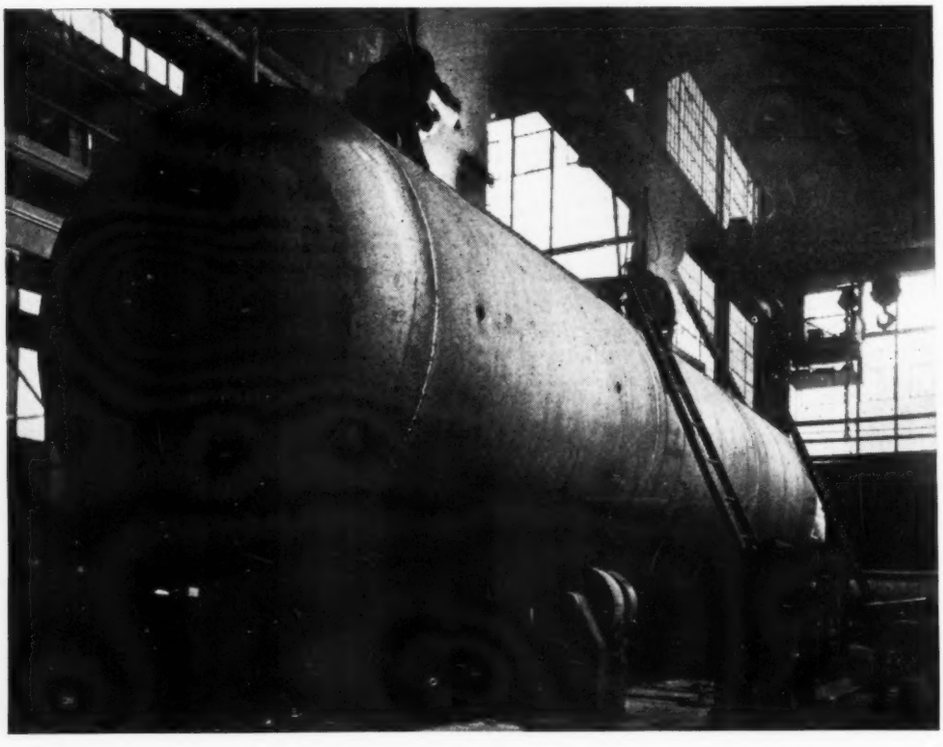
Because of the strains set up in forming the plates and the stresses resulting from contraction due to welding, it is recognized that stress relieving the completed drum or vessel is absolutely essential. Companies building heavy wall pressure vessels have learned from experience and have demonstrated not only the necessity of stress relieving but also its additional value to the customer. The Code recognizes the merit of relieving the stresses set up during welding and demands that all class 1 constructed vessels and, under certain conditions, class 2 constructed vessels, be stress relieved.

The design of the furnace is very important, since it must be of a very large capacity with positive and sensitive temperature control, uniformity of temperature and efficient in operation.

The stress relieving furnace under consideration is 16 ft. 9 in. wide by 72 ft. long inside and is practically automatic. Three position control mechanisms are used for proportioning the air and gas in the proper ratio. The products of combustion transverse a circular path, insuring uniformity of temperature and furnace balance. There are 48 burners each fitted with pilot lights. Thermo-couples are placed at various points inside the furnace and each thermo-couple is connected to recording controllers located in a central control room. The temperatures at various points in the furnace are recorded on the charts for the complete cycle of operation, and can readily be checked by the inspector to assure him of complete control.

After the stress relieving operation the drums or vessels are brought to the testing floor, where they undergo a severe hammer test under pressure, and also the regular hydrostatic test. Every inch of welded seam is minutely gone over and checked for tightness.

Although purchasers of heavy pressure vessels and drums are assured of high grade welded work when the Code requirements are fully complied with, the manufacturers of welded pressure vessels are even more jealous of their reputation and are constantly on the alert to avail themselves of every opportunity to improve their product.



Machine welding of seams on large pressure vessel

A NEW PAGE bearing application book, designated as "Bulletin 100," has just been issued by the Hyatt Roller Bearing Company.

Contents of the bulletin are divided into four sections, covering: Wound roller type bearings, solid roller type bearings, single row radial bearings, and lubrication data.

Included in the bearing sections are dimensions and load rating tables, together with typical mounting drawings, applicable to each respective type of Hyatt product. Several other pages are devoted to elements of bearing design, selection, load computation, correct assembly, and so on.

The Hyatt Roller Bearing Company advises that a copy of this bulletin may be had by engineers, machine designers, or other interested parties upon request from any of the Hyatt offices at Newark, N. J., Chicago, Ill., Pittsburgh, Pa., or Oakland, Calif.

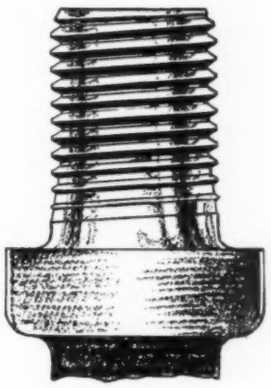
GASO PUMP & BURNER MFG. CO., First and Lansing Streets, Tulsa, Okla., announce the publication of their Bulletin No. 10, which covers a Duplex Piston horizontal fully enclosed type power pump that can be utilized for field service or on small pipe lines. Bulletins 7, 8 and 9 also illustrate and describe their latest additions to the Gaso line of all Timken bearing enclosed type power pumps for both high and low pressure.

A NEW ten-page booklet on its Zero Pressure tire has been published by The B. F. Goodrich Rubber Company, Akron, Ohio, and is now available on request to the manufacturer. Profusely illustrated, the booklet, titled "Goodrich Zero Pressure Tires for Tractors, Graders, Mowers, Maintainers," discusses the new tire product under the following headings: "What Is Zero Pressure?" "Resiliency vs. Flexibility," "Compared with Solids and Pneumatics," "Saving Time and Money," and "They Can't Go Flat."

AN ATTRACTIVE, illustrated circular, "New Speed and Power for Pipe Handling," has been issued on the Trackson Highway Pipe Layer. This unit, a combination of the Trackson McCormick-Deering Crawler Tractor and the Highway Boom, is fast, powerful, well balanced and economical. Write to either the Trackson Company, Milwaukee, Wis., or the Highway Trailer Company, Edgerton, Wis., for your copy of the booklet.

ANNOUNCEMENT has just been made by the Armstrong Machine Works, Three Rivers, Mich., of the completion of a new manual on steam trap engineering and containing complete information on the Armstrong line of traps. The book is designed to be of special benefit and interest wherever steam is used, and is said to be the most complete treatise on this phase of steam engineering that has ever been published. It is planned that with the aid of this book anyone can select the proper steam trap for cooking kettles, ironing and pressing machines, evaporating pans, greenhouse radiation, sterilizers, steam engines, separators, laundry machine, paper driers, oil refinery equipment, unit heaters, water heaters, rubber vulcanizers, textile machines, etc.

Copies of the new book are free to readers addressing either the editor of this magazine or the Armstrong Machine Works, Three Rivers, Mich.



SUCKER RODS
1 CENT PER FOOT?

AT that price most any sucker rod manufacturer ought to get business. You will agree, though, that it is highly improbable that he would keep it.

Axelson could sell you sucker rods at 1c per foot if you'd buy 'em. We will wager it would be the last purchase of rods you would ever make from Axelson, though. We've always maintained that the buyer who buys on price gets just what he pays for. The first cost of sucker rods should be, and usually is, an important item which influences the purchase. Sometimes, though, it's held so important that the operating life of the rod is forgotten. Rod breaks cost money, so much that even rods at 1c per foot wouldn't be a bargain.

Axelson doesn't claim to sell rods or couplings that never break. They do claim, however, that Axelson Rods average a minimum amount of trouble per tough pumping job. Axelson never sold rods at 1c per foot but Axelson Rods are sold at competitive prices which make them the outstanding buy in every oil field.

For the past six months we've been compiling reports on Axelson Rod performance in different fields under different conditions. In round figures, there are some 50 of 'em. We believe that out of this number you will find at least one well similar to one in which you may be having rod trouble. Perhaps the report of what Axelson Rods are accomplishing might be helpful.

Why quality material, combined with precise workmanship, give Axelson A. P. I. Sucker Rods extra long life.

Axelson Sucker Rods reach the highest standards mechanically and metallurgically.

AXELSON MANUFACTURING CO.

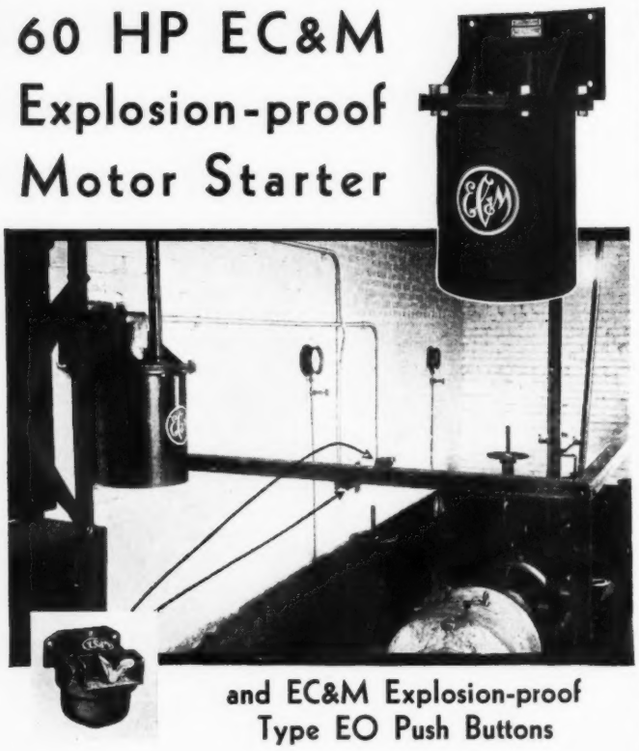
P. O. Box 710 — Vernon Station LOS ANGELES, CALIF.

Tulsa — New York, 50 Church Street — St. Louis

Mid-Continent Representatives:

Frick-Reid Supply Corporation
Great Northern Tool & Supply Co.
Norvell-Wilder Supply Co.

60 HP EC&M Explosion-proof Motor Starter



and EC&M Explosion-proof Type EO Push Buttons

Designed to meet Underwriters' Specifications in every detail. Enclosing case is of heavy construction, has wide machined surfaces between metal-to-metal joints and has tapped holes for rigid conduit connection.

Oil-immersed to be corrosion-protected—to prevent sweating—to be capable of operating for long periods of time without requiring "opening up."

Accurate protection against overloads and single phase operation. Mail the attached coupon today for complete information.

TYPE EO PUSH BUTTON RATINGS

FOR LOW VOLTAGE PROTECTION APPLICATIONS
Momentary Style

Form "A"

Form "B"

Form "C"

	A.C. With or Without Oil			D.C. Without Oil			D.C. With Oil		
Volts	110/220	440	550	125	250	600	125	250	600
Inductive Circuits—Amps.	30	25	20	2.25	.67	.20	15	7.5	3
Non-Inductive Circuits—Amps.	30	25	20	3.5	1	.30	20	10	4

FOR LOW VOLTAGE RELEASE APPLICATIONS
Maintained Style for Pumps, Lights, etc.

Form "E"

	A.C. With or Without Oil			D.C. Without Oil			D.C. With Oil		
Inductive Circuits—Amps.	30	25	20	5	1.5	.5	20	10	4
Non-Inductive Circuits—Amps.	30	25	20	7	2	.7	30	15	6

Write for Push Button Bulletin 1105

THE ELECTRIC CONTROLLER & MFG. CO.
2700 East 79th Street, Cleveland, Ohio. P.E. 12-32

Please send me literature on EC & M .....(Full or reduced voltage) Explosion-proof Starters for use with .....volt motors.

Name ..... Company .....

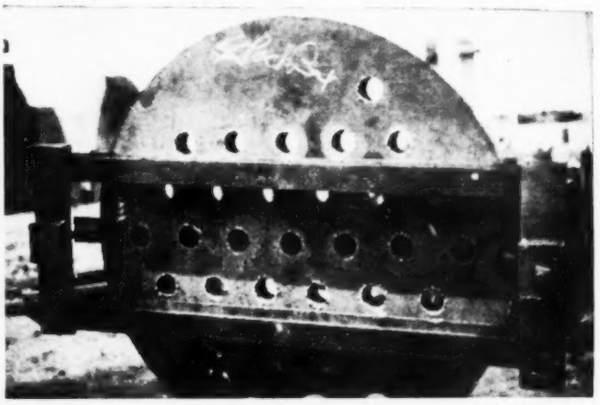
Address .....

Making a Welded Bubble Tray[1]

By D. F. GERSTENBERGER☆

THE equipment outlined herein is known to the refiner as a bubble tray. The use of this equipment is common to practically all phases of the refining industry for fractionating vapors resulting from the distillation of crude oil for gasoline, naphthas, kerosene, distillate, "lub" stocks, and also for the fractionation of the vapors produced from the cracking under pressure and high temperature of heavy hydrocarbons into lighter hydrocarbon fractions. It is also used extensively both for absorption and fractionation in plants extracting casing-head gasoline from oil well and natural gas and from refinery vapors.

Such trays are installed in what are known as bubble towers, the number of trays used in each tower varying according to the exactness of the separation desired, and the quantity of vapor to be fractionated. In general practice this number ranges from five trays per tower to as many as thirty.



Welded bubble tray.

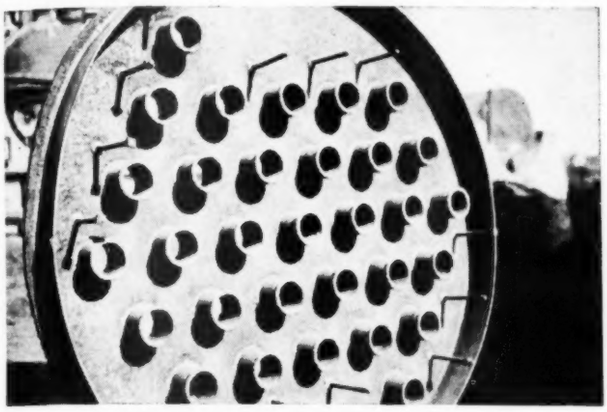
The sketch given herewith is typical of a ten-tray tower. The bubble caps as shown in the tray, due to their shape, can be most readily made of cast iron. They are independent of the tray and are placed on the tray after it has been installed in the tower, and are held in place by securing a bar across each row of caps. The tray in this instance has been fabricated by the use of the electric torch. It has been common practice, however, to make these trays from cast iron. In order to prevent warping and cracking such trays are heavily ribbed or are poured with very thick metal, thereby increasing the weight and the original cost. Patterns, of course, for such large castings are very expensive.

Some idea may be had of the extensive use of the bubble tray in the refinery when it is realized that a small plant capable of running 6,000 barrels of crude per day will have as many as 150 to 200 bubble trays in the towers of its various processes.

The accompanying photographs show one of many trays which we have fabricated entirely with the *Lincoln electric torch*, with the exception of what cutting was necessary. The plate from which the tray is made is one-half inch boiler plate, the ring around the outer edge, one-quarter inch material.

[1] Submitted for the second Lincoln Arc Welding prize competition.
☆Universal Oil Products Company.

The only difficulty experienced in first attempting to make the welded tray was a tendency to severe warping when the three-inch upflow nipples were welded in place on the plate. This was overcome by bracing with removable I-beams as shown by one of the photographs. The procedure now is to place the outside ring, tack it in a few places, bolt on the I-beam braces and then completely weld the ring. The up-flow nipples are then welded in place after which the tray is cut inside of each nipple to make the openings as shown by the photograph of the under side of the tray. Lastly, the down-spouts are welded in place.



Another view of a tray fabricated with electric torch.

The actual cost of the welded tray, including the caps, which are made in a local foundry, is as follows:

Material:	
Steel	$20.00
Ring for support in tower	10.00
Welding rods and cur.	19.50
30 bubble caps	12.00
	$61.50
Labor	16.00
Total	$77.50

The life of the welded tray should be the equivalent to the cast iron tray, and in any event, equivalent to the life of the tower itself which is made of plate. Our plant has had many welded trays in operation since August, 1930, and they are giving perfect satisfaction with no signs of deterioration.

These trays were constructed under the writer's supervision and design at this plant in Wichita Falls, Texas, which refinery is in my charge. My duties include the design of equipment and the supervision of its construction as well as the operation of the refining processes. In other words, the writer is called upon to operate what he designs and erects, and he has found the welded bubble tray entirely satisfactory in every respect, and has thereby been able to effect a radical saving to his company.

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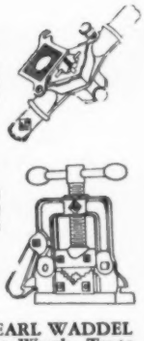

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Products That Cut Down Your Underground Overhead

Pennsylvania Refining Practice

By GEORGE KIRKWOOD

Assistant Superintendent Penna Refining Co., Butler, Pa.

IN the first process of separating Penna crude into marketable products two fractions are obtained which contain the total lubricating oil content. These two fractions are known as wax distillate and 600 steam refined stock. The wax distillate has no commercial application and must be further fractionated and refined before reaching the consumer. The 600 steam refined stock is widely used as a steam cylinder oil and is often compounded with various fatty oils for this purpose. In addition to this use 600 steam refined stock is dewaxed and the wax-free oil filtered into bright stock.

The wax distillate is chilled with cold brine from the refrigeration plant in double pipe chillers to a temperature representing the cold test desired on the finished neutral oils. It is then filter-pressed to remove the paraffin wax. In former days when only batch stills were used, it was considered necessary to crack the wax distillate in order to convert the wax into a form that would be pressable. By cracking, in this connection, is meant a distillation using very little steam and accompanied by some decomposition. The advent of the tube still and fractionating towers has proved this to be a fallacy. Well fractionated wax distillate presses very well without redistillation and it was the fractionating effect of the redistillation rather than any cracking, which made the batch-still distillate pressable.

The wax removed in the filter-presses contains about 40 per cent of oil which must be removed. This is accomplished in a process called sweating. The sweat-ovens are well insulated buildings with a number of shallow steel pans placed one above the other. A heavy mesh wire screen is supported near the bottom of the pans which are filled with water to the level of the screen and the melted wax pumped on top of the water. The wax is then allowed to solidify and when solid, the water is withdrawn and the wax cake remains suspended on the screen. Heat is then turned on in the room and as the temperature rises the oil gradually sweats out. When the oil content becomes less than 1 per cent the wax is melted down and when filtered through Fuller's earth or bone charcoal, is ready for the market as crude scale wax. The oil which sweats out is very rich in wax and, as the temperature rises, becomes more so, due to the increased solubility of wax in the warmer oil. Two cuts are usually made of this product, foots oil, which is usually mixed with wax distillate and pressed, and second cut, which is charged back into the sweat ovens to make a lower melting point scale wax.

The wax-free oil from the presses, usually referred to as Pressed Distillate, is distilled and fractionated into fuel oil, non-viscous and viscous neutrals. The viscous neutrals are residues and the other products are distillates. The viscous neutrals are usually designated 150, 180, and 200 neutrals, the numbers representing viscosities at 70 degrees F. on the old Tagliabue Viscosimeter, very few of which are in existence today. This method of specifying Penna neutrals is rather confusing and it is to be hoped that a change will be made calling for the Saybolt viscosity at 100 degrees F. The neutral oils are filtered through Fuller's earth, usually to 3 N. P. A. color and are mostly used in blending motor oils, although they are also sold as engine oils and other industrial lubricating oils.

The 600 S. R. stock is diluted with about 60 degrees of close-cut naphtha, Gr. 61.5, I.B.P.-220 deg. F., end point, 320 deg. F., and filtered to a 7 N.P.A. color in solution. It is then transferred to heavily insulated tanks containing brine coils and chilled to about 40 degrees below the cold test desired on the finished oil. The chilling tanks are equipped with a mix-

ing device to keep the wax in suspension and when the desired temperature is reached, the mixture is fed to Sharples Centrifuges, which separate the wax from the solution. The wax fraction contains about 40 per cent of naphtha, which must be distilled off. The remaining wax is known as amorphous wax and is used in making petrolatum. The wax-free solution of oil and naphtha is charged to a still and the naphtha distilled off. The remaining oil is filtered through Fuller's earth to the desired color, 6, 7, or 8 N.P.A., and blended with neutral oil to make motor oils.

This rather sketchy description of the procedure in making Penna lubricating oils is subject to many variations, but to those not familiar with Penna practice, it will give an idea as to our methods of refining.

Characteristic tests of the products mentioned in this article are as follows:

	Wax Dist.	600 S.R.	34 Neut.	150 Neut.	200 Neut.	Bright Stock
Grav. API	35.0	26.5	34.0	31.9	31.4	26.9
Flash Point	360	560	360	405	425	560
Fire Point	420	630	410	465	485	630
Viscosity	85@100	147@210	80@100	137@100	175@100	175@210
Color			1½	3	3	8

C. F. Camp Appointed McAlear Representative

C. F. Camp Company, Archer and Detroit Streets, Tulsa, Okla., has been appointed representative in Oklahoma for The McAlear Mfg. Company of Chicago, Ill. The McAlear company are manufacturers of steam, water, air, gas and oil specialties, regulators, strainers and controllers.

Southwestern Engineering Appointed Donnelly Representative

The Southwestern Engineering Corporation, Los Angeles, Calif., has been appointed exclusive representative for the entire United States of the Donnelly Process Corporation, Chicago, Ill. The Southwestern Engineering Corporation will engineer, sell, manufacture and erect cracking units to be operated under license from the Donnelly Process Corporation.

The Chain Belt Company Announces a New California Distributor

The Republic Supply Company of California has been appointed by the Chain Belt Company as exclusive California distributor for Rex Deepwell Chabelco Chains.

Rex Deepwell Chabelco Chain is built throughout with the high degree of workmanship and accuracy usually found only in high grade machines. Accuracy of pitch is maintained by alloy steel side-bars which will not stretch under the load.

These accurately made parts are assembled by hydraulic pressure into the Rex Unit Link—the link that stays a unit under the heaviest service.

Complete stocks in the principal California fields will be carried in all stores of The Republic Supply Company.

The Petroleum Engineer Increases Advertising Staff

The Petroleum Engineer announces the appointment of W. F. Thompson as Eastern manager. Mr. Thompson comes to us from the advertising staff of *National Petroleum News* and *International Petroleum Technology*. For the next two months his headquarters will be Cleveland, Ohio, 15102 Lanning Avenue, Lakewood. At the end of that time his permanent headquarters will be announced.

R. H. Deibler, who for several years was with the old *Oil Field Engineering* in the capacity of advertising representative, has been placed in charge of our California territory. He is maintaining headquarters at 1341 South Hope Street, Los Angeles.

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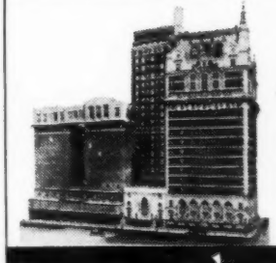

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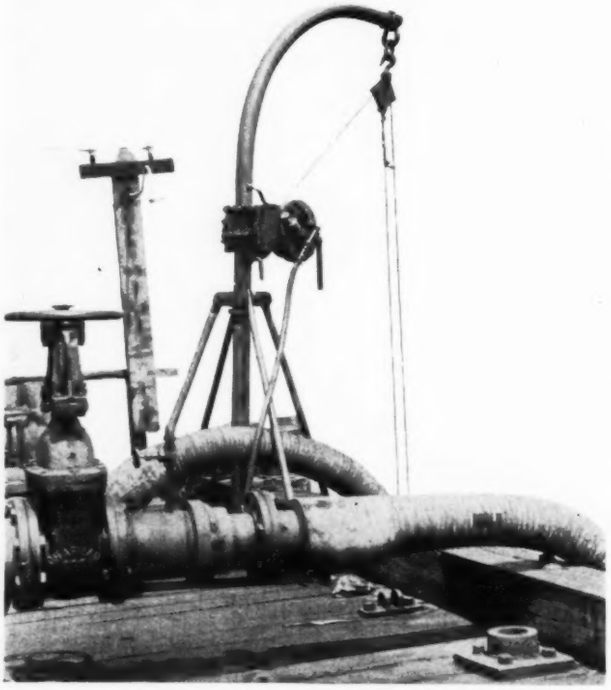
TO handle the several millions of barrels of crude oil and refined products moved monthly through the Texas Gulf Coast ports, pipe line companies and oil companies have designed and built some of the most modern terminal facilities. They make for the fast loading of an oil tanker and the maximum safety. Some of the terminals are equipped to load a vessel at the rate of 30,000 barrels per hour.

Crude and refined products are loaded in the tankers at the Texas terminals for both coastwise and export shipment. A considerable volume of coastwise and foreign shipments are received at the same ports and annually about 100,000,000 barrels are handled by the Gulf terminals.

The equipment necessary to handle such a large volume consists of both steam and electric motor-powered pumping units. Many of the older terminals are operated with steam pumps, while the more modern equipment consists of motor-driven centrifugal pumping units.

Terminal capacity varies widely, some being equipped to load at the rate of about 5000 barrels per hour, while others have facilities to load at a rate up to 30,000 barrels per hour. The terminals with facilities for the higher loading rates are usually equipped with motor-driven units.

Pumps for such installations are low head, high volume, double suction units. On the larger terminals these units are usually 10-in. or 12-in. pumps, directly connected with a flexible coupling to the motors. Power units for the centrifugal pumps range anywhere from 150 to 500-hp. motors, depending upon the requirements at the terminal.



Oil Powered Davit used to handle hose lines

In designing the pump stations the discharge lines are made as short as possible in order to obtain the maximum delivery and cut down the horsepower requirements. Discharge lines are built with pipe of various diameters up to 16 inches and the average terminal discharge line length ranges from 500 ft. to 2000 ft. The station suction lines from storage are built with large pipe varying in diameter up to 24 inches. All of the equipment in the station is installed with the view to eliminating all possible hazards from fires and explosions.

The discharge lines from the station extend to a header running lengthwise on the dock. The header is built with several connections both for 8-in. and 12-in. hose. Because of the expense in cleaning and flushing lines used in handling crude oil, it is usual practice to use separate lines for refined products at those terminals where both crude and refined products are handled.

The average tanker coming into the Texas ports has a capacity of between 75,000 and 100,000 barrels. Some of the larger vessels have a capacity of 120,000 barrels. Generally the channel depth of most of the ports is about 32 feet and the average tanker draws between 25 and 30 feet of water.

As the tanker is being piloted to the dock inspectors are going over her to make certain she is ready for the next voyage. Practically all of this work on ships, handling either a coastwise cargo or foreign consignment, is complete by the time the vessel is tied up at the dock.

In most instances it is desirable to load a tanker as rapidly as possible. For this reason the dock is the scene of rapid work moving along with clock-like precision as the tanker and dock crews start making hose connections.

Before the vessel is lashed to the dock the static ground wires have been attached to the ship's hull as a precaution against a static explosion. The heavy and unwieldly hoses are swung into place by the hand-powered or motor-powered winches. Flange bolts are pulled down tight, usually with spark-proof tools, and when all is in readiness orders are transmitted to the pump station to start the units. About 10 to 15 minutes are required to make necessary connections after the vessel has docked.

When loading at a high rate the terminal operators usually open two or three storage tanks into the station suction line to insure ample suction for the pumps. To prevent the pumps pulling a vacuum on the tanks each is equipped with a nipple and gate valve, which is wide open while the tank is in the line and its volume is being lowered rapidly. Some of the tanks have a wider base than the ordinary storage tank because soft soil conditions, sometimes encountered, make it more desirable to have the wide base.

When loading a tanker a pressure of between 40 and 100 pounds is carried in the discharge lines. While the ship is being loaded frequent samples are taken from each compartment of the vessel. From these sample gravity and centrifuge tests are made and the results recorded in a permanent record. The samples are retained a reasonable length of time in the event any question arises concerning the shipment.

Although not a frequent happening, burst hose connections may be the cause of much trouble and considerable loss. The hose is purchased in 25-ft. lengths and at many of the docks two lengths of hose are flanged together into one 50-ft. length. The heavy hose is built with rubber and a good grade of cotton. To give added strength and life the hose is sometimes spirally wrapped with a non-sparking metal ribbon.

In the event of a bursted hose while a ship is being loaded at a high rate every precaution is taken to prevent a large loss of oil or gasoline. Practically all terminals have a telephone line extending from the dock to the pump station. Other docks are equipped with push-button controls, by means of which the operators on the dock may shut down the motor-driven

For Fast Ship Loading Time

units in the event of trouble. Other dock operators may close gate valves against the centrifugal pumps to prevent as much loss as possible while the units are being shut down. Under such conditions it is difficult to prevent considerable loss, because when loading at a high rate the oil is going through the line at the rate of about 500 barrels per minute.

When a vessel is to be loaded for export to a foreign customer a closer inspection is made of the ship and its cargo. Usually an engineering firm, specializing in that work, is employed by the purchaser. The firm makes an inspection of the boat before it is loaded, making sure certain valves are closed and sealed. He agrees with the ship's agents concerning the volume loaded and the quality of the product shipped. They also assist in the preparation of papers for the clearance of the ship. By following this method the purchaser does not have to send someone a long distance to represent him while the tanker is being loaded and many disputes are eliminated.

Another reason for close inspection of export shipments is that sometimes the ship's engineers have shown a low fuel consumption on certain voyages at the expense of the cargo. Unless certain valves are sealed it would be an easy matter to run a small amount of oil from the tanker compartments to the ship's bunker and use it as fuel.

In gauging the volume of oil or gasoline going into the tanker a gauge of the shore tanks usually is sufficient. Ordinarily a ship is loaded to within about 300 barrels, plus or minus, of the volume desired. The gauger makes certain that the lines to be in service while loading the tanker are displaced with a product of about the same gravity as that in the storage tanks from which the runs will be made. An accurate gauge is taken of the tanks just prior to starting the station pumps and when loading is complete another gauge is taken and the volume delivered to the vessel is computed.

Perhaps one of the most serious hazards to terminal operation is the menace of fire and explosions. Every precaution is taken to prevent fires originating on the docks and the fire fighting methods are designed along lines to prevent spread of fires originating on the terminal site.

Huge signs and posters warn against the dangers of smoking on or about the dock. Precautions are taken against metallic sparks that might ignite gas. The docks and terminal site are kept clean as possible. All hatches are wide open while the tanker is being loaded, permitting the gas to escape into the air.

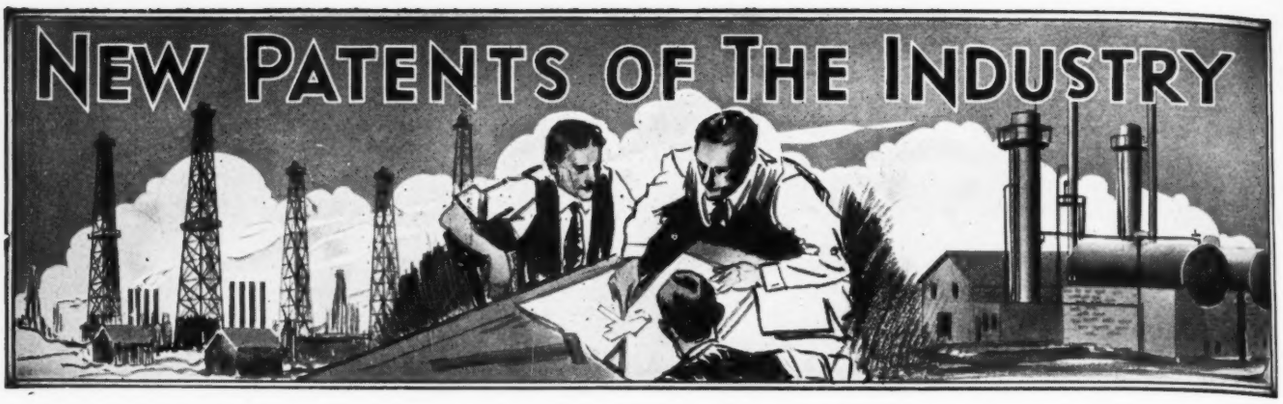
Some of the terminals are prepared to fight fires with steam while others are equipped to fight fires with water and foam. Each dock is equipped with several small hand-operated extinguishers available for instant service. At the more congested shipping points a fire boat is usually available.

Where the terminal is equipped to combat fires with foam some of the companies have foam lines extending to the storage tanks at the terminal. In the event of a fire in the tank foam is shot in at the top of the tank at a high rate. Such foam plants are inspected daily.

The docks are constructed with creosoted piling and timber. In some instances the dock floor has been covered with concrete.

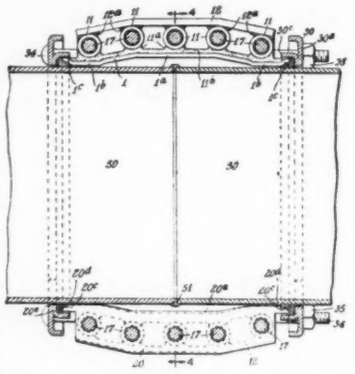
In addition to having facilities for loading and unloading tankers many companies are equipped to supply fuel oil to the ships calling at the various Texas ports. Equipment for such service consists of storage near the docks and pumping equipment designed to deliver anywhere from a few hundred barrels per hour to about 5000 barrels per hour to the ship's bunkers. A few companies maintain barges used to bunker freights or passenger vessels. These are brought alongside a boat, hose lines extended to the ship, and by means of pumps on the barge fuel may be delivered to the ship at the rate of about 500 barrels per hour.

Loading tanker with crude at a Gulf Coast terminal



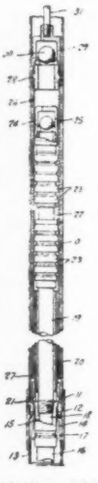
1,877,094. WROUGHT METAL REPAIR DEVICE FOR PIPE LINES. JOSEPH E. WALBORN, Bradford, Pa., assignor to S. R. Dresser Manufacturing Company, Bradford, Pa., a Corporation of Pennsylvania. Filed January 26, 1929. Serial No. 335,339. Three claims. (Cl. 285—132.)

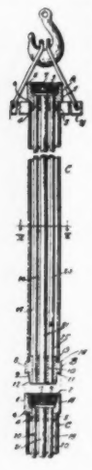
1. As a new article of manufacture, a split sleeve for repairing pipe lines, formed of wrought metal and divided longitudinally into segments, said sleeve being provided at each end with outwardly flared portions forming end packing recesses, and terminating at the edges of said recesses, each segment of the sleeve being provided along each longitudinal edge thereof with a longitudinal series of tubes welded thereto with their axes perpendicular with the adjacent edge of the sleeve segment, a separately formed reinforcing bar welded to the outer sides of the tubes of each section, side packings between the meeting edges of said segments, side clamping bolts engaging the tubes of adjacent sections, end packing rings engaging said end packing recess of the sleeve, and projecting beyond the ends of said sleeve, followers provided with annular plate members provided with bolt holes and annular plate members provided with bolt holes and annular flanges forming packing recesses, said flanges having sufficient internal diameter to fit over and reinforce the split flared end portions of the sleeve, and clamping bolts and nuts for said followers.



1,877,112. TRAVELING TUBE PUMP. JOHN A. YERKES and REES H. LEMMON, Long Beach, Calif. Filed January 3, 1930. Serial No. 418, 264. Six claims. (Cl. 103—181.)

1. In combination with a well tube having a support, an inserted well pump, mounted in said tube and on said support to seal the space above said support from that below, said pump comprising nested tubular stand pipes, one of said stand pipes being provided with a piston, said stand pipes being spaced from one another to provide an annular non-working space therebetween, openings terminating in stationary ports placing said annular space in communication with the space surrounding said stand pipes, a working barrel surrounding said piston and forming therewith a working pump space, said working barrel reciprocating with respect to said stand pipes to cause play of liquid contained in said annular non-working space and surging of such liquid back and forth through said openings.



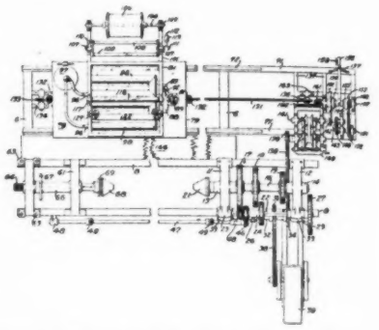


1,876,627. MULTIPLE PIPE UNIT ADAPTABLE TO THE DRILLING AND PUMPING ARTS. FRANCIS H. DAVIS and FRANK F. DAVIS, Monterey, Calif. Filed January 27, 1931. Serial No. 511,616. Three claims. (Cl. 255—28.)

1. As a new unitary article of manufacture, a multitubular pipe comprising an outer casing, a plurality of longitudinal internal tubes traversing the casing and rigidly mounted therein, a coupling element at each end of the casing having an outwardly disposed contact table and external shoulders on the coupling elements outwardly of the contact tables normally spaced when the tables are contacting to permit further adjustment of the elements to compensate for wear.

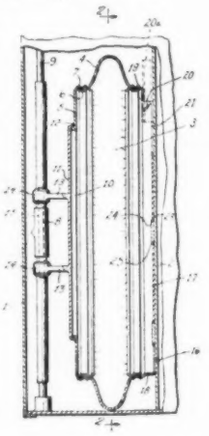
1,876,760. PIPE WRAPPING MACHINE. LELAND S. ROSENER, San Francisco, Calif., assignor to The Paraffine Companies, Inc., San Francisco, Calif., a Corporation of Delaware. Filed May 21, 1928. Serial No. 279,426. Two claims. (Cl. 242—11.)

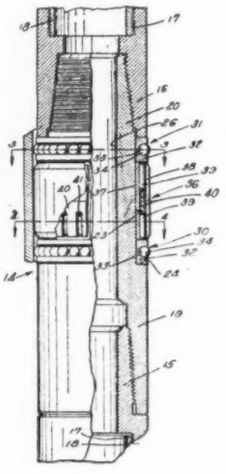
1. A pipe wrapping machine comprising means for supporting and rotating a pipe, a track parallel to the rotational axis of said pipe, a carriage movable along said track, a tank adapted to hold a fluid and movable about a vertical axis on said carriage, a gear sector fixed to said tank, a pinion meshing with said sector, means for rotating said pinion to adjust the angular position of the tank about said axis, means for moving the carriage along the track, and means for feeding wrapping material through said fluid and to said pipe.



1,876,889. GAS METER CONSTRUCTION. MICHAEL FERRANTE, Los Angeles, Calif., assignor of one-half to Southern California Gas Company, Los Angeles, Calif., a Corporation of California. Filed September 8, 1930. Serial No. 480,326. Five claims. (Cl. 73—1.)

1. In a meter construction, the combination of a casing, a measuring chamber within the casing having a bellows including a flexible apron and a movable head connected to said apron, a fixed wall within the casing opposite the said movable head, and said bellows also including a relatively fixed head in the form of a disc with a flange projecting toward the movable head for attaching the flexible apron to the bellows, said disc having spaced openings therethrough for the application of solder on the side of the fixed head remote from said fixed wall.





1,877,395. ANTIFRICTION DEVICE FOR DRILL PIPE. EDWIN W. GOESER, Los Angeles, Calif., assignor to Emsco Derrick & Equipment Company, Los Angeles, Calif., a Corporation of California. Filed May 14, 1928. Serial No. 277,630. Ten claims. (Cl. 308—6.)

1. An anti-friction device for drill pipe comprising: a sleeve bearing for absorbing friction during a rotary movement of the drill pipe; and a bearing above and a bearing below said sleeve bearing for absorbing friction during a longtitudinal movement of the drill pipe.